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Vol. 21 **No. 3**

SEPTEMBER, 1955

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100 Exhibition St., Melbourne, C.1.

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226 Clarendon St.,
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ARTICLES

REVIEW OF MYXOMATOSIS IN AUSTRALIA, 1950-1955

By F. N. RATCLIFFE

Since reporting on myxomatosis developments at the 1952 meeting of the Australian and New Zealand Association for the Advancement of Science, the face of much of the eastern half of the continent has been transformed as a result of the widespread and drastic reduction in rabbit numbers due to the disease. During the three intervening years, the infection has spread until it has become virtually coextensive with the rabbit, has maintained its endemicity everywhere (as far as we can tell) flaring up in season to cut back the young generation that had bred up since the previous epidemic. At the time of writing, rabbit numbers over much or most of South-eastern Australia approach the lowest in living memory, though there are patches of moderate infestation here and there.

Once it was apparent that myxomatosis was essentially an insect-borne infection, the work of the field officers of the Wildlife Section was directed to getting a thorough understanding of the ecology of the insects likely to be involved in its transmission; for it was clear that the incidence of myxomatosis in space and time, and in degree, must be a reflection of the local abundance of vectors.

A fairly satisfactory picture has emerged from the vector investigations. The picture is only "fairly" satisfactory because the area involved is huge, so that intensive studies have had to be restricted to a few localities selected as representative of substantial regions. Many interesting outbreaks have occurred in out-of-the-way places which could not be investigated and which cannot be adequately explained on our knowledge of the insects likely to have been involved. It has become obvious that even the best techniques available for the quantitative assessment of vector activity are not sensitive enough to deal satisfactorily with mobile insects in low density. Long drawn-out myxomatosis activity at low intensity (which can be caused by efficient vectors in small numbers, inefficient ones in greater abundance, or a sequence of different vectors) has often been puzzling to us. Yet such outbreaks can be of very great epidemiological interest and practical importance; for they may ultimately result in a high-grade kill, and are likely to extend into or through a breeding season. In general, where clearly-defined "sharp" epidemics are the rule, these tend to occur when rabbits are not actively breeding, so that the subsequent build-up of the population is not noticeably affected by the disease

Insect Vectors—the General Picture

The Wildlife Section's field studies over the past three years have given new emphasis to the importance of mosquitoes as myxomatosis vectors, and have indicated how these insects could, in some types of country, keep the infection going at a "maintenance" level as well as producing the sharp epidemic outbreaks. Evidence incriminating insects of other groups remains scanty and rather unsatisfactory. Ceratopogonidae (sandflies) appear to be of negligible importance. Technical difficulties preclude the positive incrimination of fleas and other ectoparisites as vectors in the field. Circumstantial evidence has suggested transmission by the cat flea in one outbreak in northern New South Wales in

F. N. RATCLIFFE B.A. is Officer in Charge of the Wildlife Survey Section of C.S.I.R.O. in Canberra. *This paper was delivered at the Symposium on "Myxomatosis" held by Section I of A.N.Z.A.A.S., August* 17-24, 1955.

1952; but against this we have to record the failure of the infection to spread in rabbit populations infested with stick-fast fleas (*Echidnophaga* sp.) in parts of Western Australia, despite large-scale inoculations.

The small, stockily built, black flies of the family Simuliidae (breeders in running water, for which Australians have no popular name) are the only insects, other than mosquitoes, which we know can attain importance as vectors of myxomatosis. They seem to have been solely or mainly responsible for some localised outbreaks during spring and autumn; but their main role is probably that of disseminators of the infection, leaving the task of intensive local transmission to other vectors. One species at least (*Austrosimulium furiosum*) we know to have an unusually great flight range—up to or over 50 miles—and its abnormal and widespread abundance during the 1952/53 season probably contributed significantly to the extraordinary spread of the disease that year. Now that what might be termed the colonizing spread of the virus seems to be complete, it is possible that the importance of vectors that are mainly long-range disseminators of the infection may be reduced; but there are clear indications that local extermination of the virus must occur in areas of intense epidemic activity, so that insects habitually ranging (and carrying the infection) over distances measurable in tens of miles may still have an important role to play.

Turning now to mosquitoes, our investigations have not thrown much light on the vector species operating in the lower-rainfall, inland zones of myxomatosis activity. The major vectors, *Culex annulirostris* and *Anopheles annulipes*, occur but sporadically in these regions; but species unimportant elsewhere (e.g., *Aedes tremula*) have been revealed as rabbit-feeders, and probably played a vector role. Some of the most effective epidemics (covering far western New South Wales, northern South Australia and parts of Central Australia—which we were unable to investigate) occurred under conditions which almost certainly favoured the widespread abundance of *A. annulipes*.

In the coastal and near-coastal belts, where intensive investigations have been carried out during the last season or two in selected sites, a complex situation has been revealed. Recoveries of virus from mass collections of mosquitoes made in various ways have shown that several species may be involved in transmission, either simultaneously or serially. The puzzle has been to explain the timing of the usually clear-cut epidemic outbreaks; for they can rarely be correlated with the seasonal appearance, in numbers, of a vector of known high efficiency. Observations indicate that meteorological conditions, affecting mosquito behaviour, can modify the transmission rate. Thus it was found that not only hot, dry weather, but a period of continuous rain and drizzle, encouraged *Anopheles annulipes* to seek harbour in rabbit burrows. On the whole it may be said that while we now know quite a lot about the species which transmit myxomatosis in this region, this knowledge is not sufficiently complete or precise to form the basis of prognostications.

The Two Most Important Vectors—Culex annulirostris and Anopheles annulipes

Over a wide belt of country lying west of the Divide—a belt including much of New South Wales and Victoria, and of great importance both from the point of view of wool production and rabbit infestation—the spread and performance of myxomatosis depends primarily on two species of mosquitoes, *Culex annulirostris* and *Anopheles annulipes*. Both are normally active only at and after dusk, and are unobtrusive compared with the day-biting pest species of *Aedes*, which occur in great abundance after suitable rains and are of negligible or no importance as vectors.

C. annulirostris and *A. annulipes*, although frequently found breeding and

feeding side by side, differ importantly in their ecology and behaviour. The former appears to be very sensitive to low atmospheric humidities, and rarely ranges far beyond the tree belt fringing rivers and swamps. In a normal season it can be expected to produce epidemics of high intensity and great effectiveness, but markedly delimited in space. During the summer just past, however, high humidities were maintained for a time over a substantial section of south-eastern Australia; and *Culex annulirostris* suddenly appeared as a widely ranging insect, and undoubtedly played a very significant role in the highly satisfactory development of myxomatosis activity that followed.

Anopheles annulipes has been found to possess a behaviour pattern and adaptability which combine to ensure a high level of efficiency as a vector (though this may not be much in evidence in the more coastal areas). As a species it is beautifully adapted to existence in areas of erratic rainfall, being relatively insensitive to low humidities, and being widely ranging and long-lived. Its habit of harbouring in rabbit burrows—and, it is believed, feeding on rabbits underground—greatly increases its potentialities as a myxomatosis vector. Until the biology of this remarkable mosquito became properly known, widespread outbreaks of the disease in months of dry heat, and in the apparent absence of insect vectors, remained a puzzling mystery.

We now know nearly enough about *Culex annulirostris* and *Anopheles annulipes*, and their requirements in terms of rainfall distribution for the production and maintenance of high populations, to be able to calculate the probabilities of the occurrence of "good myxomatosis years" in the regions which they dominate as vectors. The 1952-53 season was exceptionally favourable for *Anopheles annulipes*, both in the plains and the undulating and foothill grazing country watered by spring-fed streams. During this season myxomatosis not only reached most areas to which it had not spread during the two preceding years, but effected such a widespread and drastic reduction in rabbit numbers that, in general, they failed to make a substantial comeback under the conditions that ruled the following year, which was markedly less favourable for vector activity and disease transmission.

Some Practical Points from a General Review

Reviewing the situation and prospects from the practical viewpoint of rabbit control, several points deserve special mention. First, now that we have passed out of the stage of initial surprise and anticipation, when the sighting of a few sick rabbits in a "new" area provided noteworthy evidence of myxomatosis spread, we know that continuing effective control must depend on recurring high-grade kills. Occasional epidemics resulting in mortalities of up to 50 or 75 per cent. may have an alleviating value, but cannot be expected to be of more than temporary significance. We are not yet in a position to delimit the areas in which outbreaks of "controlling" intensity can be expected to occur annually over an average run of seasons. For the last half-dozen years, south-eastern Australia has enjoyed better than average seasons. While allowing for the fact that a season which favours rabbit breeding will also tend to favour mosquitoes, and *vice versa*, we must be cautious in generalising from the results of myxomatosis during the past few years. Seasons of "grass rains", with insufficient run-off to fill dams and provide surface water, are well known and must be expected to recur: they would favour the rabbit but not myxomatosis.

Second, in the pattern of performance of myxomatosis since its release in 1950, the vector and transmission factor (determining the local *infection rate*) has completely overshadowed the effect of attenuation in the prevalent strains of the virus, resulting in the reduction of the *case mortality rate* from over 99 per

cent. to about 90 per cent. The effect of this attenuation is noticeable in certain well-checked populations, where an infection rate of virtually 100 per cent. has been attained in each annual epidemic; but it is only reasonable to expect it would be well masked over a wide region in which local infection rates may be at any level, down to zero. Until and unless the case mortality rate of the prevalent strains slips back a further 10 per cent, or so, when "controlling" kills would virtually cease to occur, the effect of decreasing virulence will not become generally obvious.

Third, the matter of the artificial dissemination of the infection—"inoculating campaigns"—presents a very serious challenge. In view of the fact that the disease has shown itself liable to turn up anywhere, without human assistance, and flare up into epidemic outbreaks when conditions favour transmission, and that the widespread prevalence of attenuated strains points to a consistent failure of introduced "standard" virus to compete with the locally established types, one is tempted to question the value of systematic inoculation. However, it is quite clear from the conclusions of the genetical studies reported by Sobey (1955) that an attempt to re-establish fully virulent strains is—apart from intensifying survivor destruction by standard methods—the only positive action that can be taken to postpone the effects of an increasing innate resistance of the rabbit to myxomatosis. It is obviously desirable to determine how and when inoculations should be planned and carried out so as to improve the chances of maintaining a virulent type of infection in the field.

The Uncertain Future

Lastly, we would like to be more certain than we can be at present of the degree to which myxomatosis alone is responsible for the present eclipse of the rabbit in south-eastern Australia. That it is primarily and very largely responsible there can, of course, be no shadow of doubt; but for sound prophesying one must be able to assess the part played by accessory factors which might not always operate in the same direction or degree. "Mopping up" by standard methods of control has played an important part in many districts; and while it must and will always be encouraged, individual effort could easily tend to slacken off when results were not so obvious and readily obtained.

Hardest of all to assess is the possibility that the rabbit population of Australia is subject to alternating periods of increase and decrease (some sort of cycle, in fact) not directly attributable to seasonal conditions. The evidence for this is still scanty, but accumulating and not safely to be ignored. The fact that rabbit numbers in many areas are lower than seems explicable by the observed mortality from myxomatosis leads to the suspicion that, at any rate since 1952-53, the disease has been working in a population in process of a natural temporary decline.

Developments over the next few years should help to clear up this and other uncertainties in the myxomatosis picture. Looking back, it can be seen that the major events in the history of myxomatosis in Australia could not have been predicted on the knowledge available at the time. Thus it is possible that factors at present unrecognised (and therefore not assessable) may be operating in this very complex situation, and that the apparently well justified anxiety as to the continuing efficacy of myxomatosis might prove to be unfounded.

Acknowledgment

In the course of this paper, I have drawn freely, without specific acknowledgment, from the work of colleagues in the Wildlife Section, B. V. Fennessy, K. Myers, A. L. Dyce, G. W. Douglas, and E. J. Waterhouse, the results of which will be published in due course.

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CHANGES IN THE INNATE RESISTANCE OF RABBITS TO MYXOMATOSIS

By W. R. SOBEY

The increasing number of immune wild rabbits in a population after successive epizootics of myxomatosis, observed by Professor Fenner and his co-workers, has led to concern as to the future of myxomatosis as a biological control of rabbits in Australia. Professor Fenner has suggested a number of factors which, operating alone or in combination, could account for changes in case-mortality. (Fenner, 1953.) One of these factors, genetic changes in the resistance of the rabbit population, is the subject of the present paper.

Repeated epizootics have killed off a large percentage of some populations and it would seem reasonable to expect the genetic makeup of survivors to be such that they were more resistant than the original population. Until recently, there has been very little evidence on which to base a prediction. Martin (1936) bred from a number of rabbits which had survived an infection of myxomatosis and infected 35 of their offspring with a virulent virus. All of these died. These results did not preclude genetic resistance but suggested that any such resistance was unlikely to have immediate dramatic effects in reducing the effectiveness of the disease.

Deliberate selection for resistance under laboratory conditions is being carried out by the C.S.I.R.O. Animal Genetics Section in Sydney. In this work, which is still in its preliminary stages, rabbits are selected for resistance to an infection of a fixed dose of one of the slightly attenuated strains of myxoma virus. The breeding plan is designed to enable a measure of the genetic changes taking place with selection to be made. Comparison of average survival times and percentage mortality made between the offspring from animals which had survived an infection of any one of the field strains of virus and offspring from normal controls, indicate some degree of genetic control over resistance. Insufficient data are as yet available to determine quantitatively the magnitude of this genetic control.

Professor Fenner and his co-workers have studied case-mortalities of rabbits born in different sections of the population which have undergone different numbers of epizootics. Young rabbits were collected during periods when the disease was dormant, from specified areas whose history in regard to myxomatosis was known. These were reared under laboratory conditions and, at about 4 months of age, were infected with a fixed dose of a slightly attenuated strain of myxoma virus. From these data, which are to be published in detail elsewhere, it has been possible to measure changes in both survival time and percentage mortality with increasing number of epizootics experienced by the parent population. By extrapolation of these measurements it is possible to predict that a percentage mortality of 50 per cent. will be reached in 5 to 10 further epizootics. Changes in the genetic make-up of rabbits in the field, as measured from the above data are relatively small but agree with this prediction. The above measurements, being made on offspring reared in the laboratory, are independent of variations in field conditions. Thus fairly large changes in density of rabbits due

W. R. SOBEY Ph.D. is Research Officer with the Animal Genetics Section of C.S.I.R.O. at Sydney University. *This paper was delivered at the Symposium on "Myxomatosis" held by Section I of A.N.Z.A.A.S., August* 17-24, 1955.

to causes other than myxomatosis are unlikely to affect the prediction.

It must be emphasised that the prediction made above only holds if a slightly attenuated virus predominates in the field. If the fully virulent virus were the only virus in the field the development of genetic resistance would be very slow, provided resistance were not highly inherited, since very few animals are left to breed after an epizootic and their progeny would be practically wiped out in the succeeding epizootic. There is, however, strong selection for the slightly attenuated strains of the virus in the field (Fenner, 1955). Many more rabbits are available to breed after infection with these viruses and even with a relatively poorly inherited degree of resistance, effective selection for resistance can take place. Studies on the release of French virus at Lake Urana (Fenner, 1955) indicate that the French virus predominated for the first half of the epizootic, after which the slightly attenuated strains took over from it. It may be assumed that the release of virulent Australian virus at the beginning of an epizootic will follow a similar pattern.

It is suggested that since some genetic control of resistance has been demonstrated, rabbits will eventually develop complete immunity, first to the attenuated strains and later even to the virulent myxoma virus. The usefulness of myxomatosis as a biological control of rabbits will diminish quickly as the percentage mortality in the field approaches 50 per cent., when rabbit numbers can be expected to increase rapidly. Present evidence indicates that this point may be reached in roughly 5 more epizootics. Since this is due to the predominance of slightly attenuated strains of virus in the field, it is suggested that the continued release of fully virulent virus be maintained at as high a rate as possible to slow down the development of genetic resistance.

Acknowledgment

I am indebted to Professor F. Fenner and his co-workers for making available their data and to Dr. P. J. Claringbold for his co-operation in their analyses.

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CHANGES IN THE VIRULENCE OF MYXOMA VIRUS ASSOCIATED WITH ITS NATURAL TRANSMISSION IN POPULATIONS OF THE RABBIT *ORYCTOLAGUS CUNICULUS*

By FRANK FENNER

Introduction

As Ratcliffe (1955) pointed out in his survey, spread of myxomatosis is dependent on the occurrence of large enough numbers of efficient insect vectors. The vector situation is thus the most important single factor affecting the control of rabbits by myxomatosis, for without vectors epizootics will not occur. It is an interesting consequence of the purely mechanical nature of the transmission of myxomatosis and thus its lack of vector specificity (Day, 1955) that every year since 1950 there has been a major epizootic of myxomatosis in some part of the rabbit-infested areas of south-eastern Australia, even though the weather has varied greatly from year to year and from one part of the area to another. It seems likely, therefore, that effective spread of myxoma virus may be expected to occur almost every year in some part of the large rabbit-infested area of south-eastern Australia, though the major vectors and the extent of the epizootics will certainly vary. Under these circumstances it may be legitimate to shift the emphasis from the problem of vectors to a consideration of the host-parasite interaction. Myxomatosis will be effective in rabbit control only if it is associated with a very high case-mortality rate. Sobey, (1955) has discussed the effect genetic changes in the innate resistance of rabbits may have on the case-mortality rate. My objective is to examine what changes have occurred or may occur in the virus which would affect its killing capacity, assuming that there is no change in the resistance of the rabbit. This is obviously an artificial situation, for neither innate resistance nor virus virulence can be considered in the absence of the other; indeed Sobey has pointed out that in the dynamic situation obtaining in Nature there is an important interaction between them. But experimentally we can study them as independent entities, in the first case by standardizing the strain, dose, and route of inoculation of the virus; and in the second by testing potentially different virus strains in a relatively uniform stock of laboratory rabbits, none of whose progenitors have been exposed to myxomatosis.

Virulence is used to describe the lethality of myxoma virus under certain standardized conditions, and strains can be further described as *fully virulent, slightly attenuated* or *greatly attenuated.*

Changing Case Mortality Rates

Indication that the mortality rate from myxomatosis was falling in certain areas became obvious early in 1952, during the course of serological surveys of wild rabbit populations. Early in 1953 Dr. Mykytowycz reported the recovery of a strain of virus which was undoubtedly less virulent than the strain originally released, and all our subsequent experience has confirmed the fact that many strains of virus recovered from naturally-infected cases of the disease are attenuated.

F. J. FENNER, M.B.E., M.D., B.S., D.T.M., is Professor of Microbiology at the Australian National University, Canberra. *This paper was delivered at the Symposium on "Myxomatosis". held by Section I of A.N.Z.A.A.S., August* 17-24, 1955.

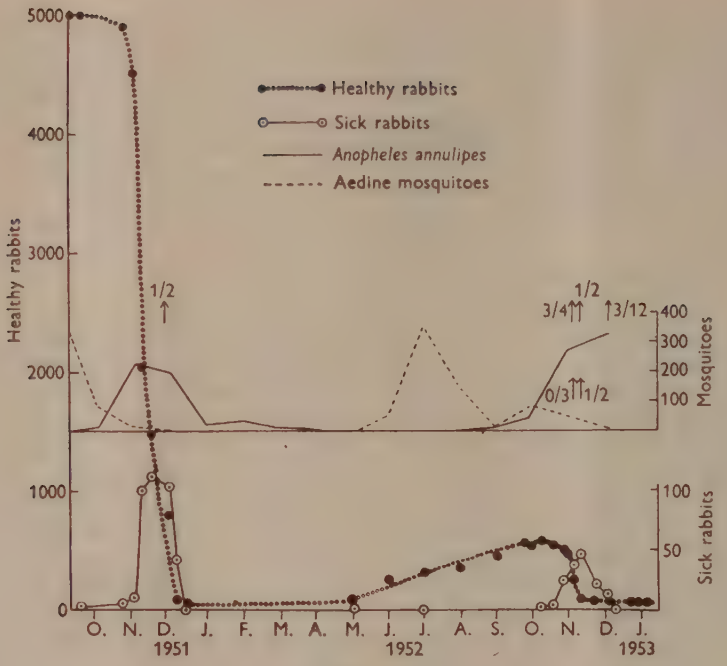

Figure 1.
Population counts of rabbits and adult mosquitoes at Lake Urana, New South Wales. The arrows indicate the occasions on which virus was recovered from batches of mosquitoes (Anopheles annulipes in upper line, aedine mosquitoes in lower) and the proportion of isolations to batches tested. (From Myers, Marshall and Fenner, 1954.)

There is only one area where information of any accuracy is available on the effect of this attenuation on the case mortality rate from myxomatosis in a wild rabbit population, and that is Lake Urana in southern New South Wales. Laborious and painstaking work here by Mr. K. Myers, correlated with laboratory studies carried out by Mr. I. D. Marshall, have produced the picture shown in figure 1.

In this locality the virus inoculated into captured rabbits in October, 1951, caused an outbreak of myxomatosis with a case mortality rate of 99.5%. The virus persisted locally through the winter, at a very low level of activity, and spread actively again the next summer. The second outbreak, in a much smaller rabbit population, was characterized by a distinctly lower case mortality rate:—about 90% in the susceptible rabbits.

A Laboratory Test for Virulence

Several strains of virus were recovered from rabbits and mosquitoes during this second outbreak at Lake Urana, and the problem arose of devising a practicable method of determining differences in virulence of the order suspected from the field data, i.e., differences of 99.5% and 90-95%. The problem proved easier than expected. As our interest lay in the performance of different virus strains under natural conditions an attempt was made to imitate natural infection in experimental rabbits. The simplest analogy of infection by mosquito bite appeared to be the intradermal inoculation of a small dose of the virus, and this was the method adopted. It was soon apparent that the progress of the disease initiated by small doses of the original standard laboratory strain of myxoma virus differed from that

caused by the field strains obtained from Lake Urana. The local lesions at the site of inoculation differed in character, and the symptoms developed more slowly with the attenuated strains. Recovery, in the groups of five rabbits routinely used, was rare, but survival times were almost invariably prolonged. The average survival time was selected as the best single criterion for comparison. Differences in survival time were easily demonstrated and comparison of survival times and mortality rates in two large groups of rabbits inoculated with the standard laboratory strain of virus, and a slightly attenuated field strain, suggested that we were justified in considering that these differences reflected differences in the mortality rates (Table I).

This appeared, therefore, to provide a method of comparing the virulence of strains of myxoma virus, whereby small differences in the mortality rate were correlated with differences in average survival time—a figure which could be determined on small groups of rabbits. The result of the application of this technique to strains of myxoma virus recovered from the field in Australia are shown in Table II. These tests were carried out on some 80 strains of virus, tested in about 500 laboratory and 200 wild rabbits. It will be appreciated that it is possible to present only a greatly simplified view of the situation, based often on one or two samples of virus from areas in which several strains of differing virulence may have been simultaneously circulating. There appears to be no practicable way of overcoming this limitation, which is imposed by sampling and testing difficulties.

Attenuated Strains in Australia

The widespread occurrence in the field of slightly attenuated strains is clear, as is the rarity of both the fully virulent and of greatly attenuated strains. Some of the most attenuated strains were recovered quite early, in 1953, but they do not appear to have spread—indeed samples recovered from Uriarra in 1955 were distinctly more virulent than Mykytowycz's strain, recovered in February, 1953. The results so far suggest that a slightly attenuated strain of myxoma virus, associated with an average survival time of about 25 days in our experimental rabbits, and a case mortality rate of about 90% under field conditions, is better adapted to survival and spread in Australia than either the highly virulent standard laboratory strain, which has been repeatedly introduced during inoculation campaigns, or very attenuated strains.

The greatest attenuation yet observed in field strains is associated with case-mortality rates of the order of 70%. Some information concerning the degree of attenuation possible is given by Hurst

TABLE I.

Comparison of mortality rates and average survival times of Australian wild rabbits challenged by the intradermal inoculation of 5 rabbit-infectious doses of the standard laboratory strain of myxoma virus or the slightly attenuated Australian field strain KM13,

No. of rabbits	Strain of virus	Mortality Rate	Average survival time (days)	
			All rabbits*	Fatal cases only
34	Standard	100%	10.9	10.9
180	KM13	81%	28.0	24.0

*Survivors allotted a survival time of 60 days.

(1937) who described a variant of myxoma virus recovered by intracerebral passage of the virus in rabbits, and he called this variant neuromyxoma. When tested by our standard method this virus fails to kill rabbits, although it occasionally makes them sick. Such animals are solidly immune to infection with virulent myxoma virus. It is obviously of major importance to know whether this neuromyxoma strain, or any other of similar properties, could spread in the field. This question is dealt with in this Symposium by Day (1955) in his account of the transmissibility of different strains.

Myxomatosis in Europe

Myxomatosis is not confined to Australia, but since 1953 has caused tremendous epidemics in the wild rabbits of Europe, including Great Britain. The virus used to initiate the epizootics in Australia was first recovered in Brazil in 1911. It passed to the Rockefeller Institute in 1924, thence to England in 1934, to Australia in 1936, and was finally successfully disseminated in the field in Australia in 1950. During all this time it was maintained by serial passage in laboratory rabbits. The European outbreak, on the other hand, was initiated by a strain of virus which was only three or four domestic rabbit passages away from its native host, the Brazilian wild rabbit, *Sylvilagus braziliensis*. The clinical symptoms of myxomatosis in *Oryctolagus cuniculus* due to these two strains of virus differ considerably. The disease due to the European strain of virus is much more florid, and is characterized by much larger tumours and greater oedema than the disease caused by the standard laboratory strain, although the survival times of rabbits infected with the latter are slightly shorter.

TABLE II.

The virulence of strains of myxoma virus recovered from the field in Australia. Mean survival times of groups of five laboratory rabbits challenged with 5 rabbit-infectious doses inoculated intradermally.

		Mean survival time		
		< 15 days	15-30 days	> 30 days
Virus for distribution				
C.S.L.		1		
Glenfield		1		
I.M.V.S.		1		
Virus recovered from field				
Queensland	1951-52	2	0	0
	1952-53	0	4	0
N.S.W. and A.C.T.	1950-51	1	0	0
	1952-53	1	14	1
	1953-54	0	4	1
	1954-55	1	7	0
Victoria	1951-52	3	0	0
	1953-54	1	4	1
	1954-55	1	5	0
South Australia	1953-54	2	1	0
Western Australia	1954-55	1	0	0
Tasmania	1953-54	1	2	0
Totals—field recoveries		14	41	3

The European experience as far as the maintenance of virulence is concerned is summarized in Table III. It is dramatically different from the Australian experience. Until April, 1955, nearly three years after the original inoculation, not one attenuated strain was recovered—and our experience, shown in the table, accords with the more extensive but perhaps less precise observations of European workers.

Release of European Strain of Virus in Australia

This stability of high virulence, not any intrinsically greater virulence, was the reason for attempting to introduce the French strain of virus on an experimental scale in Australia. The results of this experiment, carried out by W. E. Poole and I. D. Marshall, are shown in figure 2. The French strain became firmly established in the local rabbit

TABLE III.

The virulence of strains of myxoma virus obtained from America and Europe. Mean survival times of groups of five laboratory rabbits challenged with 5 rabbit-infectious doses inoculated intradermally.

Place of Origin	Mean survival time	
	< 15 days	20-30 days
Brazil and Uruguay	3	
California	2	
France and England		
1952 (inoculated)	1	
1953	3	
1954	7	
1955	2	2

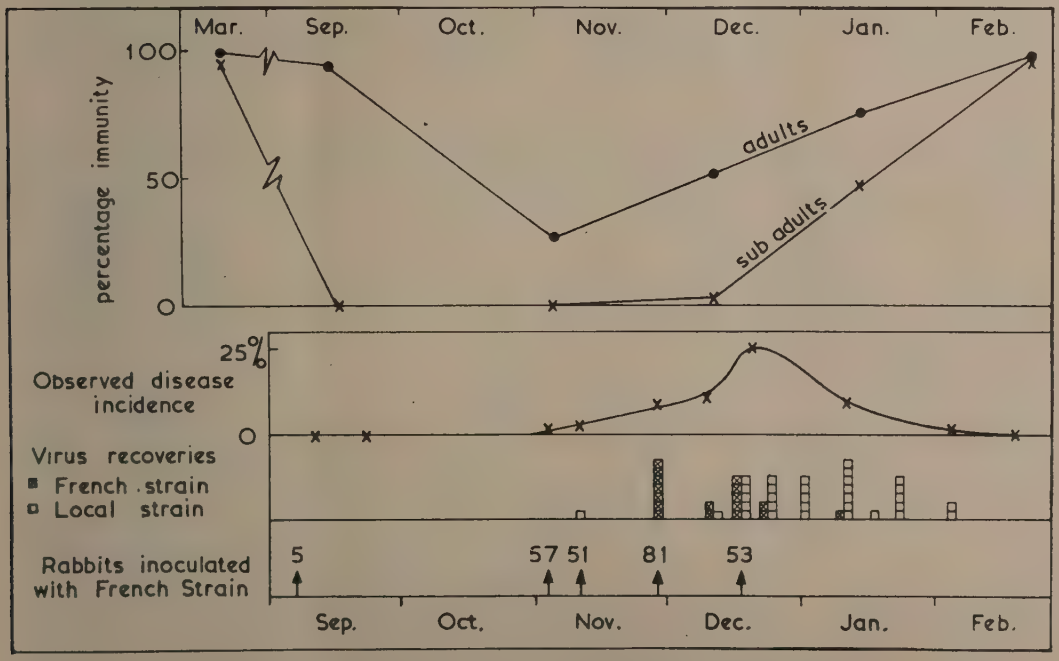

Figure 2.

The release of French strain virus at Lake Urana in the summer of 1954-55. The results of serological surveys, observations of diseased rabbits, and examination of virus strains recovered are shown. Virus recoveries refer to naturally-occurring cases—each square representing one case.

population, but with the progress of time it was completely replaced by the slightly attenuated local strain. A similar sequence of events was observed at another locality in southern New South Wales. In direct competition it appears that the slightly attenuated Australian strains are better adapted for survival than either the highly virulent standard laboratory strain, or the virulent French strain. As Day (1955) shows, this is probably due to the longer survival, in a highly infectious condition, of rabbits infected with the attenuated Australian strains.

The available information on the virulence of myxoma strains is summarised in Table IV. Although there are many minor discrepancies, all strains examined so far fall in a broad way into one of six groups. Starting from the original standard laboratory strain we have one greatly attenuated laboratory variant, neuromyxoma, and two less attenuated field variants. Of these the KM13 type is much commoner, and is distinctly more virulent than the rarer Uriarra type. The Lausanne strain is representative of all strains recently derived from South American *Sylvilagus*, and the great majority of strains recovered from the European outbreaks are indistinguishable from the Lausanne strain. Included in the Table is the "Loiret 55" strain, which is the first attenuated strain to be recovered in Europe, and is distinctly different from any of the attenuated derivatives of the standard laboratory strain.

Possible Changes in the Host Parasite Balance

A talk on the epidemiology of myxomatosis would be incomplete without some speculations about the future of the disease. As far as its occurrence is concerned, it seems likely that even in the absence of any further purposeful introduction the virus is firmly established in the rabbit population of the country, and could be eliminated only by elimination of the host. The occurrence of epizootics will depend on the local vector situation, but history so far suggests

TABLE IV.

Characteristics of different strains of myxoma virus, observed in laboratory rabbits inoculated with small doses of virus.

Strain	Mean survival time (days)	First appearance of generalization (days)	Time of closure of eyes (days)	Character of skin lesions	Estimated mortality rates in wild rabbits	Estimated period of infectivity of infected rabbits (days)
Standard laboratory	11	6-7	9-11	moderately raised, no distinct edge	>99%	6
Neuromyxoma ..	all survive	6-7	never	slightly raised, distinct edge, early central necrosis, rapid healing	0	8 very low
KM13	23	6-8	14-18	slightly raised, no distinct edge	90%	30§
Uriarra	38*	6-7	11-12†	large, slightly raised, well demarcated edges	?70%	10§
Lausanne	13	6-7	9-11	large, greatly raised, hard, deep purple colour, no distinct edge	>99%	8
Loiret, 55	27	7-8	17‡	large, greatly raised, deep purple colour, well demarcated edge	?90%	30§

* = survivors allotted survival time of 60 days.
† = closure of eyes not invariable.
‡ = eyelids greatly distorted but eyes usually not closed completely.
§ = approximate periods, varying with the survival times of individual rabbits.

that in south-eastern Australia epizootics will with rare exceptions be an annual event, though they may vary greatly in their extent and intensity. Sobey (1955) has discussed the changes which may occur in the genetic resistance of the rabbit. I do not think the virus will become more attenuated and the host more resistant until it attains the situation found in *Sylvilagus braziliensis*. Australian experience so far suggests that attenuation is not progressive, but that a strain of virus with quite high virulence may be better adapted for survival than greatly attenuated strains. And consideration of the situation in South America suggests that the benign behaviour of myxoma virus in *Sylvilagus braziliensis*, and its extraordinary virulence for *Oryctolagus*, are both biological accidents rather than the result of long evolution, in the first case, and lack of it in the second. There are several species of *Sylvilagus* rabbit which occur in areas of North America where myxomatosis is quite unknown. Inoculation of myxoma virus into these rabbits, which have certainly undergone the later stages of their evolution in the absence of the virus, leads to precisely the same condition as is found with *Sylvilagus braziliensis*—namely, the production of a benign lump, with no systemic symptoms. And the very high virulence of myxoma virus for *Oryctolagus* is not the result of repeated passage in that host, for each of three strains of virus recovered from spontaneous epizootics in Brazil (and therefore only a few *Oryctolagus* passages from *Sylvilagus*), has proved highly virulent for laboratory rabbits, producing symptoms of the type associated with the French strain of virus.

Naturally occurring virus strains appear, by and large, to have retained the present level of virulence for over three years now, and Day shows that greatly attenuated strains like neuromyxoma could not successfully compete with the existing field strains. The probable reason for the failure of the Uriarra strain to spread is that in most rabbits the virus titre of the skin lesions falls rapidly after the sixteenth day, so that the average period of infectiousness of this type of strain may be quite short.

The present balance—a dominant field strain which kills about 90% of infected rabbits and negligible change so far in the innate resistance of the rabbit—is highly effective in rabbit control, but it is a precarious balance. The reproductive potential of the rabbit is so great that a small change in the case mortality rate—say from 90% to 60% or 70%, and an occasional season with few vectors, could allow a great upsurge in rabbit numbers. Sobey has indicated that it is just this situation—a slightly reduced case mortality rate—which will accelerate the selection of genetically more resistant rabbits. Indeed he has pointed out that although there has been a negligible change in innate resistance so far, with viruses of the KM13 type dominant, the trend is clearly towards a relatively rapid rise in innate resistance even if there is no further fall in virus virulence.

Natural selection of the virus is determined by its transmissibility by insect vectors, a subject treated by Dr. Day elsewhere in this Symposium. The interaction of changes in genetic resistance of the rabbit, and changes in the virulence of the virus, may lead to a stage where the standard laboratory strain of virus may become dominant, although by that time it will not cause a 99.5% case mortality rate in wild rabbits.

Human action cannot affect the vector situation. It can, by destruction of survivors, delay the emergence of genetic resistance in the rabbits, and inoculation campaigns with highly virulent virus may also have this effect.

The present stage of myxomatosis in Australia is a most interesting one, and the changes which occur in rabbit and virus during the next five years will almost certainly decide the long-term future of the disease as a method of rabbit control. We must now concentrate

research on problems which are fairly clearly defined, but which are considerably more difficult than those tackled so far. And we cannot expect answers quickly. We may have to wait until 1960—a decade after its introduction—to give a reasonably sound forecast of the ultimate place of myxomatosis in rabbit control.

Acknowledgment

This summary records the results of laboratory work carried out in the Department of Microbiology, Australian National University, in collaboration with I. D. Marshall. For the supply of virus strains we are deeply indebted to Mr. Ratcliffe and officers of the Wildlife Survey Section of the Commonwealth Scientific and Research Organization in Australia, to Drs. Lépine and Jacotot of the Pasteur Institute, Paris, to Mr. J. R. Hudson of the Veterinary Laboratory, Weybridge, England, to Dr. H. de Beaurepaire Aragao of the Oswaldo Cruz Institute, Rio de Janeiro, and to Dr. D. G. McKercher of Davis, California.

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(*Received for publication August*, 24, 1955).

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See also Appointments Available, Page XI.

FACTORS INFLUENCING THE TRANSMISSIBILITY OF MYXOMA VIRUS BY MOSQUITOES

By M. F. DAY

Summary

The strains of myxoma virus so far recovered from the field are acquired and transmitted by the mosquito vector with approximately equal efficiency. Yet experience has shown that one strain can replace another under natural conditions; it seems likely that the increase in survival potential of strains is to be correlated with the length of time they present viruliferous lesions to biting mosquitoes.

Although mosquitoes carry the virus mechanically, species may differ in their efficiency as vectors. These differences are probably correlated with structural differences in the mouthparts. None of the other factors that have been studied affect the transmission of myxoma by mosquitoes.

Introduction

Collaborative work between the Department of Microbiology of the Australian National University and the C.S.I.R.O. Division of Entomology established soon after the first Australian epizootic of myxomatosis got under way, that the virus was transmitted mechanically; the mosquito vectors were likened to "flying pins". This fact, together with the knowledge that the virus has in Australia no alternative vertebrate host, suggested that the epidemiology of the disease should be fairly simple and that the disease was maintained in nature by the uncomplicated cycle:

——→Oryctolagus ——→arthropod vector ——→Oryctolagus ——→

Subsequent work has demonstrated that there are a number of complexities in this apparently simple cycle, and it is the purpose of this paper to review what we have learned of these. Our aim has been to help to clarify the epidemiological picture by appropriate laboratory investigations. The factors we have studied involve variations in the virus, in the vector, and in the vertebrate host. We will consider them in this sequence.

The Virus

Fenner (1955) has pointed out that strains of myxoma which differ in virulence occur in the field in Australia. It was important to learn whether these were all equally transmissible by mosquitoes, and so comparative tests have been carried out using *Aedes aegypti* as the vector. If a single mosquito probes an infectious lesion and is then permitted to probe a series of marked sites on a susceptible rabbit it will often transmit the disease on a number of these occasions. This is indicated by the appearance of local lesions 3 or 4 days later at the site of biting (see Figure 1). When this is repeated with a number of mosquitoes, it is found that the probability of successive probes causing an infection decreases exponentially with the number of probes. If such an experiment is performed immediately after an infectious feed and also after an interval of, say, 2 or 3 days, three parameters can be calculated. These are the average initial virus load acquired by the vector, the average number of infectious units wiped off the mouthparts at each subsequent probe, and the mean rate of inactivation of infectious units due to other causes. These parameters have been determined for 5 myxoma strains and the results are presented in Table I, which also includes data on the mean survival time of rabbits infected with small doses of each myxoma strain under laboratory conditions. It will be observed that the standard labora-

M. F. DAY, B.Sc., Ph.D., is Principal Research Officer engaged on virus vector investigations with the Division of Entomology C.S.I.R.O., Canberra, A.C.T. *This paper was delivered at the Symposium on "Myxomatosis" held by Section I of A.N.Z.A.A.S., August* 17-24, 1955.

TABLE I.

Mosquito Transmission Characteristics of Four Strains of Myxoma Virus.

Virus Strain	Transmission by A. aegypti			Estimated mean period of infectivity of infected rabbits (Days)
	Minimum initial virus load	Amount of virus lost on successive probes (% of load)	Amount of virus lost per day (% of load)	
Standard	3.1	19	45	6
Lausanne	7.8	12	20	8
KM13	1.2	35	—	30 (approximate)
Neuromyxoma ..	0	—	—	8 (very low infectivity at all stages)

tory strain, the Lausanne strain from Europe, and strain KM13 from Lake Urana are all transmitted with approximately equal efficiency. However, the laboratory variant neuromyxoma is transmitted much less readily than the others.

It would be expected that the transmissibility of a mechanically-transmitted virus would be related to the amount of virus in the skin available to the vector. Figure 2 shows changes with time of virus titres in the skin of rabbits infected with the five strains examined. The correlation with transmissibility of the strain is close. This correlation is further illustrated by a test in which the ability of lesions of strain KM13 to provide virus for probing mosquitoes was studied at intervals during the course of the disease (see Table II). It was found that lesions remain infectious for mosquitoes until they regress and become dry and crusted, i.e., about the 14th day with neuromyxoma and about the 40th day after infection with strain KM13.

Although the KM13 and Lausanne strains are transmitted with roughly equal efficiency by *Aedes aegypti* in the laboratory, a trial carried out by Fenner in collaboration with the Wildlife Survey Section showed conclusively that strain KM13, in which the rabbit survives about 27 days, can replace in the field the Lausanne strain, in which the mean survival time is about 14 days (Fenner, 1955). The explanation for this is almost certainly to be found in the length of time that lesions remain infectious. That is to say that the ability of a strain to infect mosquitoes will, other things being equal, be greater the longer the lesion remains capable of being probed by the vector.

There is a possibility that the distribution of virus in the skin may vary from one strain to another. Virus is certainly not distributed randomly within a lesion, but is aggregated. This is apparent from the distribution of mosquitoes that become infectious after probing a lesion,

TABLE II.

Comparison of Virus Titre in Skin Slices of Myxoma Lesions of Rabbit Infected with Small Doses of Strain KM13, and the Ability of Mosquitoes to Acquire Virus from the Lesions.

Time after infection (Days)	Mean virus titre*	Mosquitoes infected %
8	—	25
15	5.8	41
22	6.1	56
30	6.9	20
37	6.8	16
44	6.3	0
50	5.6	—

*Titre expressed as rabbit infective particles per gm. of tissue in $\log_{10}$ units.

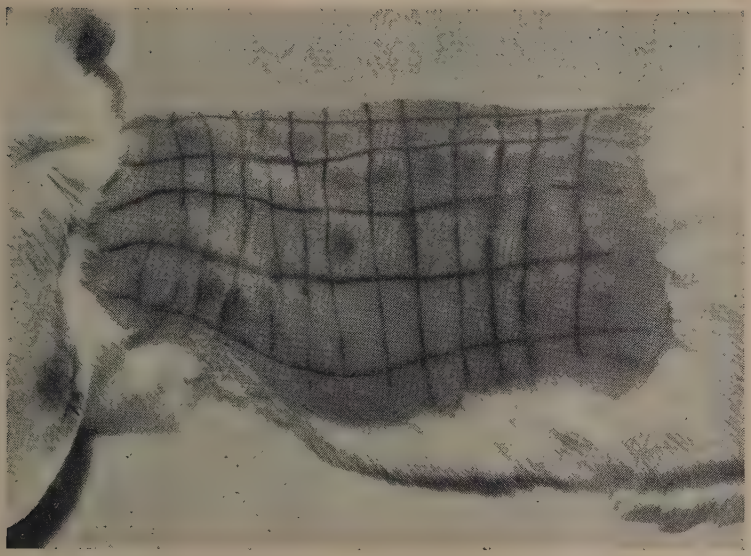

Figure 1.
Appearance of shaved back of white rabbit infected with myxomatosis by mosquito bites. Primary lesions occur at sites of infective bites.

and has also been demonstrated histologically by using antibody coupled with a fluorochrome as a histological stain. The little comparative work we have done with this technique suggests that differences between strains in distribution of virus in the skin would be inconsequential so far as mosquito transmission is concerned.

The Vector

The second group of factors contributing to complexity in the epidemiology of myxomatosis relates to the vector. If the vector is merely a "flying pin" it might be assumed that different species of mosquito would transmit with equal efficiency.

A comparison was made between the abilities of *Aedes aegypti* and *Anopheles annulipes* to transmit the standard strain of myxoma, and a few data have also been obtained with *Aedes alboannulatus* and the cat flea *Ctenocephalides felis* (see Table III). It is quite evident that *Anopheles annulipes* is a much more efficient vector than *Aedes aegypti*. *Aedes alboannulatus* seems, on the few data available, to occupy an intermediate position.

Not only is the initial virus load greater for *Anopheles* than *Aedes* but the duration of retention of the virus (or in other words, the number of rabbits that are potentially able to be infected subsequently) is also greater.

The explanation of these differences is probably related merely to the structure of the stylets. It is not known where the virus is actually carried, but the teeth on the maxillary stylets are probably involved and, although these are fairly constant within species, they vary considerably between species. Photomicrographs of the maxillary teeth of several rabbit-feeding mosquitoes are shown on Figure 3.

It should be emphasised that there is no shred of evidence that the virus multiplies in either *Aedes* or *Anopheles*. We have good reason for the view that transmission by all vectors is effected mechanically.

Of course, the behaviour of species of mosquitoes primarily determines their

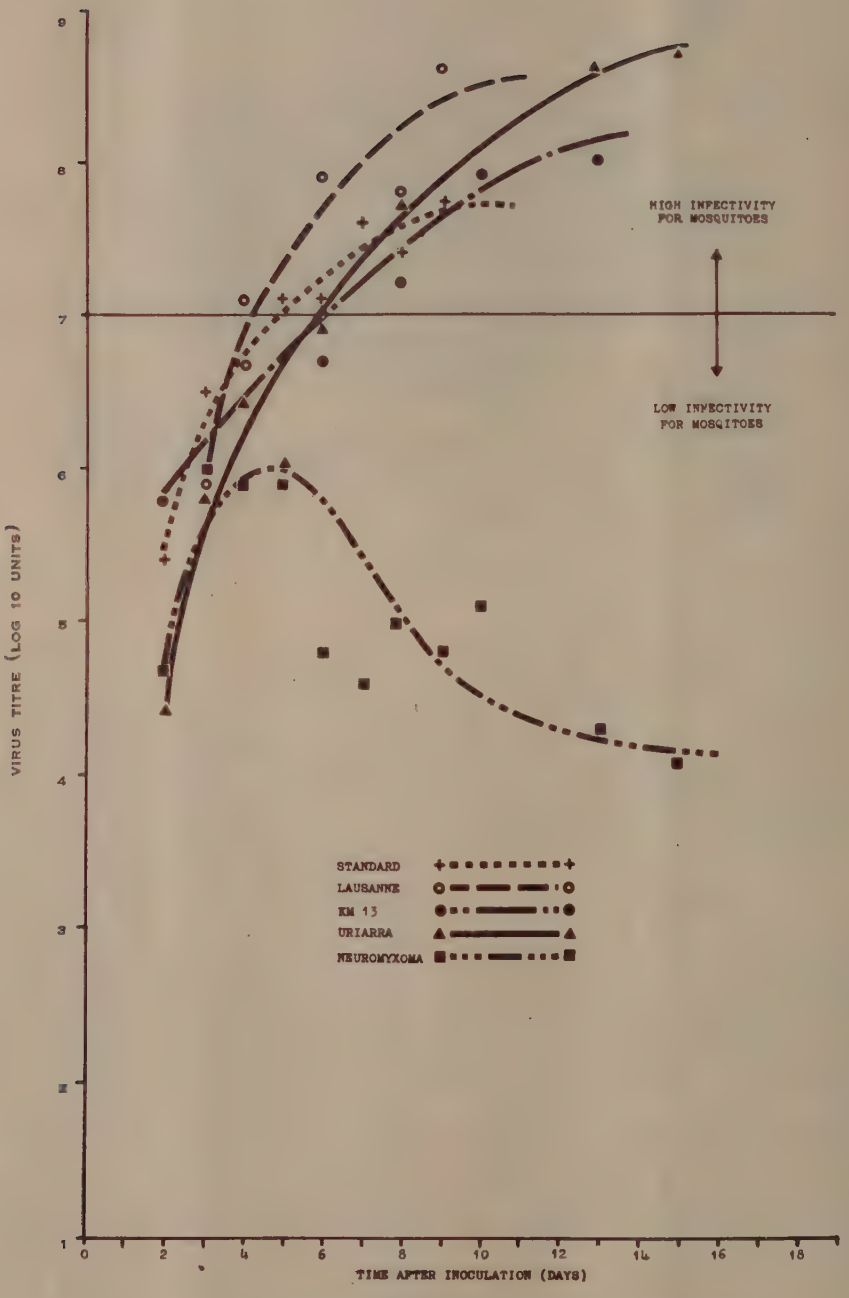

Figure 2.
Changes with time of amount of virus in primary lesions of five strains of myxoma virus.

suitability as myxoma vectors; their frequency of rabbit feeding, their feeding times in relation to rabbit ecology; their flight range, longevity and so on. All these must be considered in assessing the vector potential of a species of mosquito —but they are not usually amenable to quantitative measurements in the laboratory and we have done no work on them.

Virus has been recovered from the following species caught in the field by members of the Wildlife Survey Section: *Anopheles annulipes, Culex annulirostris, Aedes theobaldi, Aedes alboannulatus, Aedes notoscriptus* and *Culex pipiens australicus.* On the basis of precipitin tests on blood fed mosquitoes collected in the field, Lee, Clinton and O'Gower (1954) have suggested that *A. annulipes, C. annulirostris* and *C. pipiens australicus* are the most important vectors.

It is regrettable that no work has been published on the mechanism of transmission by the rabbit flea *Spilopsyllus* which English workers consider has been mainly responsible for the spread of the disease in Britain, for preliminary work by Bull and Mules (1955) on the stick-tight flea suggested that this species would be able to infect only one, two, or three rabbits after leaving the moribund infected host. It would be of interest to know whether the same is also true of *Spilopsyllus.*

The Vertebrate Host

It has already been shown how the duration of survival of the rabbit infected with various myxoma strains influences the epidemiology of the disease. Genetic changes in the rabbit would, of course, also affect the epidemiology, as discussed by Sobey (1955). There are certain other details that we have already investigated. First, what is the effect on its ability to transmit myxomatosis of feeding an infectious mosquito on an immune rabbit? If the virus is carried mechanically on the stylets the bathing of these in rabbit serum containing a high titre of circulating antibody might neutralize the infectious virus. Thus the presence of numbers of immune rabbits in a population could have an effect on the transmission of the disease greater than would be accounted for by their effect on herd immunity alone. This possibility was studied as follows: Twenty-two mosquitoes which had probed through a myxomatosis lesion were immediately allowed to take a blood meal on a marked site of a normal rabbit and another 20 were allowed to do the same on the myxoma-immune rabbit whose serum produced 99.2 per cent. reduction in the pock count on the chorio-allantois. Two days later each mosquito was induced to probe 7 times on marked sites on normal rabbits. Nineteen of the 22 mosquitoes fed on a normal rabbit after the acquisition probe produced lesions, whereas no lesions appeared on the immune rabbit. Thirty-eight of 105 probes by the 15 mosquitoes which had obtained a blood meal on the normal rabbit were infectious, and 50 out of 119 probes by 15 mosquitoes of those fed on the immune rabbit produced lesions. It is therefore apparent that a subsequent blood meal on an immune rabbit has no effect on the

TABLE III.

Comparison between Ability of 4 Vectors to Transmit Myxoma Virus. (Number of infections as percentage of total probes).

Vector	No. of Insects	Probe No.								
		1	2	3	4	5	6	7	8	9	10
Aedes aegypti	24	29	25	5	12	8	0	8	8	5	12
Anopheles annulipes	24	79	71	38	62	54	38	44	38	25	20
Aedes alboannulatus	6	67	67	67	50	33	33	67	50	33	33
Ctenocephalus felis	6	33	0	33	17	0	0	0	17	0	0

Figure 3.
Photomicrographs of maxillary teeth of species of Australian mosquitoes.

virus load on the stylets of infected mosquitoes.

A second possibility is that in a simultaneous infection of a rabbit by a mosquito of both myxomatosis and Murray Valley encephalitis (MVE) the rabbit could be protected against the myxoma virus. This was originally suggested by the finding of Ginder and Friedewald (1952) that large doses of another neurotropic virus, namely, Semliki Forest Virus was able to protect rabbits against myxomatosis. Preliminary experiments in 1952 by French and Fenner (see Fenner, 1953) suggested that MVE might behave similarly to Semliki Forest Virus.

About 100 *Aedes aegypti* were made infectious for MVE by feeding them on a suspension of MVE infected mouse brain containing a high titre virus. Twelve days later these and normal mosquitoes were permitted to probe a myxoma lesion, and were then induced to bite normal rabbits. None of the rabbits simultaneously infected with MVE and myxomatosis showed any deviation from the expected results of infection with the myxoma virus alone. In other words, doses of MVE of the size injected by a mosquito were incapable of influencing the course of myxomatosis in the rabbit when the two viruses were inoculated simultaneously.

One final point requires consideration. It is an interesting observation that although the "standard" strain first released in Australia has frequently produced strains of attenuated virulence in the field under Australian conditions, the strain released first in France and which has now covered vast areas in eastern Europe has, during the two seasons since

its appearance, apparently produced attenuated strains very infrequently. The suggestion has been made by British workers that transmission in Europe is by contact or by the flea, whereas in Australia transmission is mainly by the mosquito and it is in this vector that attenuation has occurred. Although several aspects of this hypothesis appeared highly unlikely, it was nevertheless thought advisable to study the effect of mosquito passage on the myxoma virus. A rabbit was infected with the standard strain of myxoma and 7 days later approximately 30 mosquitoes were fed on the primary lesions. These were then released into a cage and kept for 2 weeks. They were then permitted to bite a rabbit on which they produced typical primary lesions. Further groups of 30 mosquitoes were fed on these lesions, and this cycle of virus of 2 weeks in mosquitoes and one week in a rabbit was maintained for eight mosquito passages. The symptoms of the disease in each rabbit were carefully noted, but no sign of any alteration from the original strain of virus was seen. It is probable that the occurrence of attenuated strains in Australia is a function of the mutability of the standard strain first released rather than of its method of spread in the field.

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REPORT ON THE CONSERVATION OF CITY WASTE

BY A SUB-COMMITTEE OF THE AUSTRALIAN INSTITUTE OF AGRICULTURAL SCIENCE

This report was prepared by a Sub-Committee of the Victorian Branch of the Australian Institute of Agricultural Science.

The Sub-Committee was established under the convenorship of R. O. KEFFORD, B.Agr.Sc., Vegetable Research Officer in the Victorian Department of Agriculture. Its members were:—

G. W. LEEPER, M.Sc., Associate Professor of Agricultural Chemistry, University of Melbourne.

C. N. FRYER, C.E., L.S., M.I.E. Aust., City Engineer, City of Camberwell. (Co-opted.)

E. FORBES MacKENZIE, M.B., B.S., D.P.H., District Health Officer, Department of Health. (Co-opted.)

J. R. MacKENZIE, B.C.E., M.I.E. Aust., Senior Administrative Engineer, Melbourne & Metropolitan Board of Works. (Co-opted.)

P. MOORISH, B.Sc. (Eng.), Senior Engineer, Department of Health. (Co-opted.)

J. B. MULVANY, B.C.E., M.I.E. Aust., Manager, Latrobe Valley Water and Sewerage Board. (Co-opted.)

MISS ROSE MUSHIN, M.Sc., Ph.D., Lecturer in Agricultural Bacteriology, University of Melbourne. (Co-opted.)

F. WILLIAMS, M.Sc., Dip.Ed., A.R.A.C.I., Deputy Chief Chemist, State Laboratories. (Co-opted.)

Summary.

Garbage can be composted successfully, with or without the addition of sewage sludge, and plants for its disposal by fermentation, and sale as compost are in operation in many parts of the world, and are producing a satisfactory organic manure. On the other hand, many plants have closed down because of mechanical difficulties and high costs. The Committee cannot recommend composting as an economical method of garbage disposal in Victoria for the following reasons :

(1) The composting plants which have been developed so far require a large labour force for hand sorting and mostly present a dust and odour nuisance in closely settled areas. Moreover the capital cost of installation is very high.

(2) Composting would be an additional charge on the cost of garbage disposal and farmers would not be prepared to pay a sufficiently high price for compost to cover this extra charge.

(3) Moreover the method at present used of tipping and covering garbage is satisfactory and there are sufficient tipping sites within the Melbourne Metropolitan area to satisfy the demands of most Municipalities for many years.

Sewage sludge contains much useful organic matter and fertiliser material. However, the present methods of disposal of sewage are most economical and health regulations prevent the sale of all the forms of sludge produced in Victoria at the present time.

Composting Garbage and Sewage Sludge. The Commission of Public Health would not agree to the sale of such compost using the forms of sewage sludge produced in Victoria at the present time, this is because of the difficulty of supervising the process to ensure that all portions of the compost heap reach the lethal temperature for pathogenic organisms and parasitic ova.

Introduction

There will be an increasing demand for organic manures from market gardeners and orchardists in coming years. At the same time, cities are finding difficulty in disposing of their waste materials. The Chamber of Agriculture of Victoria requested the Victorian Branch of the Australian Institute of

Agricultural Science to study the possibility of solving the problem of city waste disposal simultaneously with providing organic manure.

Organic Manure

Demand and Availability

The management of the soil by market gardeners and orchardists raises two problems; to supply plants with nutrients, and to keep the soil in a good physical state. The first problem is largely met by the use of concentrated fertilisers, the main exception being on sands, which lose soluble salts too easily in the drainage water. The second problem is more complex. On large farms, it is solved by spelling the land under pasture called "ley farming" but with small farms, intensively used, this may not be possible and there is a choice between the new and expensive soil conditioners and the traditional addition of bulky manures. The common manures used in Victoria are stable manure and fowl manure. Stable manure supplies have declined to a very low level in the past 15 years causing an increasing demand for fowl manure. The supply of fowl manure has also decreased due to the adoption of the deep litter system and, as a result market gardeners now compete for these manures by providing straw for stables and fowl pens.

The estimated total demand for organic manures in Victoria is 150,000 tons (see Table I), however a much greater quantity of organic manure would probably be used if it were available at an economical price. The available supplies of stable, fowl and other organic manures in Victoria amount to approximately 100,000 tons which therefore leaves an estimated unsatisfied demand for organic manures in Victoria of at least 50,000 tons.

Supplies of organic manure which could be made available by the composting of garbage are estimated at 34,000 tons. This figure is obtained by taking Melbourne garbage at 140,000 tons per annum 60% of which (i.e., 84,000 tons) is compostable; also 60% by weight of this compostable material would be lost during the composting process.

In addition approximately 10,000 tons of dried sewage sludge are produced in Victoria at the present time.

Thus it can be seen that there is a demand for all the possible supplies of organic manures available from garbage compost and sewage sludge.

Use of Organic Manures.

The physical properties of organic manures are the most important as these manures open up heavy soils which are high in silt or clay, thereby improving aeration and penetration by water, they also aggregate sandy soils. The organic matter of sandy soils may be the only means of holding essential plant nutrients against washing out by the rain, and protecting the soil against fluctuations in acidity and alkalinity.

TABLE 1.

Demand for organic manures—estimated figures for Victoria.

Vegetable Acreage using Organic Manures	20,000 acres
Rate of Application of Organic Matter by Vegetable Growers . .	5 tons per acre per annum
Demand for Organic Matter by Vegetable Growers	100,000 tons
Demand for Organic Matter by Orchardists . .	50,000 tons
Total	150,000 tons

The direct chemical supply of nutrients from the organic manures is variable and depends on their composition. If the composition is just right, the micro-organisms release useful elements (especially nitrogen) at just the right rate for absorption by plants. On the other hand, if the organic matter is unbalanced, in particular if it has a wide C/N ratio, micro-organisms compete with the crops for the available nitrogen (or other element)

TABLE II.

Fertilising value of organic manures.

Type of Organic Manure	Analysis		
	Nitrogen N%	Phosphorus P_2O_5%	Potassium K_20%
Heat dried activated sewage sludge ..	2.5-8.0	1.9-7.0	0.13-0.75
Digested Sewage Sludge, M.M.B.W. ..	3.3	1.45	0.59
Dried Sewage Sludge	2.74	1.05	—
Raw Sludge	3.61	1.09	0.67
Fowl Manure	1.25	1.5	0.8
Stable Manure	0.7	1.0	0.6
Cow Manure	1.0	0.75	0.6
Sheep Manure	1.75	1.0	0.6
Garbage Compost—			
Auckland, N.Z.	2.32	1.41	0.73
Dannevirke, N.Z.	1.58	2.50	0.43
Dumfries, Scotland	1.0-1.3	0.5-0.6	0.3-0.35
Treated Garbage Manure, Victoria ..	1.27	1.47	0.36
Compost, Victoria	1.06	0.40	0.93
Blood and Bone	5	14	—

and the crop suffers. Table II. gives an idea of the fertilizing value of various organic manures. In addition to major elements organic wastes contain variable quantities of "trace" elements and these are often useful.

It is clearly shown in Table III. that the total quantity of the nutrient elements in city wastes is not large and amounts to only a small fraction of the concentrated fertilisers which are applied to the soil annually.

Price of Organic Manures.

Market gardeners pay £17 to £18 per acre for organic manures, that is, for approximately 3½ tons of fowl manure, or 5 tons of raw stable manure at the fowl pen or the stable.

Therefore they would be prepared to pay from £3 to £5 a ton for garbage compost, or sewage sludge, depending on the rate of application needed to be as effective as 3½ tons of fowl manure.

There are not many figures available on prices of compost from full-scale plants in operation. However "Eradite," a sewage sludge-garbage compost produced by the Dumfries County Council, Scotland, sells at £5stg. per ton. When costs in Great Britain are related to costs in Australia, it is estimated that this figure would be £10 per ton. In Oakland,

TABLE III.

Comparison of fertilizer elements in Melbourne waste with amount of artificial fertilizer used annually.

	Concentrated fertilizers used in Australia 1952/53	Fertilizer in Melbourne Sludge	Fertilizer in Melbourne Garbage
	Tons	Tons	Tons
N	18,000	1,200	400
P_2O5	322,000	350	225
K_20	11,000	200	150

California, garbage compost costs $34 a ton which, related to Australian costs and currency, is estimated at £12 per ton.

Figures are not yet available from the Canterbury County Council garbage composting plant, which is the only full-scale plant in Australia. However it is suggested that a reasonable estimate for cost of production of garbage compost in Victoria would be £10 per ton. This price would be too high for the farmer and sales would be limited to home gardeners. Further, it is doubtful whether the value in return of crop resulting from the application of the compost would justify the expenditure of £35-£40 per acre as other more economical methods, such as green manuring can be used for maintaining soil organic matter on closely cultivated properties.

Composting of Garbage

Composting of Municipal waste material has been practised in Europe for many years. The most extensive composting units in Europe are in Holland, where more than 160,000 tons of compost are produced annually from Municipal refuse by V.A.M. (Refuse Disposal Company), a non-profit public utility. Experimental work in Europe, United States of America and New Zealand has shown that organic garbage can be composted successfully with, or without the addition of sewage sludge. However, many plants have been closed down because of uneconomical operation, or mechanical failure.

Operations Involved in the Composting Process.

Any process for the composting of garbage requires the following steps:—

1. Collection of crude refuse.
2. Hand picking for large objects.
3. Shredding through a rotary or shaker screen.
4. Separation of ferrous materials with a magnetic separator.
5. Hand-picking for non-ferrous materials, paper and textiles.
6. Treatment in a pulveriser or teaser.
7. Digestion in aerated piles or maturing bins with drainage.
8. Screening and bagging of final product.

The report on Reclamation of Municipal Refuse by Composting by the Sanitary Engineering Project of the University of California includes the following extracted conclusions explaining these operations:—

(1) Factors fundamental to composting are those fundamental to any aerobic biological process—
  (i) Initial population of micro-organisms.
  (ii) Available nutrients.
  (iii) Temperature.
  (iv) Degree of acidity.
  (v) Moisture.
  (vi) Aeration.

(2) Micro-organisms are indigenous to Municipal refuse in such great numbers as to make inoculation superfluous.

(3) Shredding of garbage accomplishes mixing and aeration and facilitates bacterial invasion of refuse by breaking down natural barriers and exposing greater surface to attack.

(4) Normal city refuse contains nutrients sufficient for rapid aerobic composting.

(5) In a typical compost of Municipal refuse the temperature rises to 50°C. within one day to more than 60°C. in two to three days. A maximum temperature of 73° to 75°C. is attained during the composting process sufficient to kill both pathogens and flies in all stages of development. Heat lost in the process of turning is regained in two to twelve hours.

(6) Turning appears to be the best practical method of supplying the oxygen requirements of aerobic bacteria.

(7) Grinding of refuse is necessary for rapid aerobic composting, but the material must not be pulped lest it become too soggy to compost. If a hammermill is used, a 1½ in. screen opening should be the minimum.

(8) Ground refuse may be composted in a pile, or bin. The maximum height of the pile should not exceed 5 or 6 ft. and should not be less than 4 ft. The maximum width of pile should be approximately 10 ft.

(9) Composting may be done in the open, in dry climates.

(10) Turning a compost accomplishes aeration, ensures uniform decomposition, and exposes all pathogens and insect larvae to lethal temperatures inside the pile.

(11) Turning should be done on or about the third day after grinding and repeated at intervals thereafter, depending on the moisture content of the pile.

(12) The moisture content for good composting depends upon the nature of the material. For Municipal refuse, it lies between 40% and 65%. Excessive moisture may be reduced by daily turning, or by the addition of straw, soil, paper, etc.—turning is the most suitable. (The moisture content of Berkeley refuse, after grinding, averaged 49%.)

(13) For rapid composting without loss of Nitrogen, a C/N ratio of 30-35 is needed. The C/N ratio of mixed Berkeley refuse averaged 33.

(14) A compost is nearing completion when its temperature begins a steady decline. Finished compost is characterised by—
  (i) Dark grey, or dark brown colour.
  (ii) Neutral, slightly musty or earthy odour.

(15) The time required for composting varies from approximately 12 days for a C/N ratio of 20, to about 21 days from a C/N ratio of 78.

(16) Regrinding of finished compost makes it more uniform in texture, improves its appearance and increases the ease of applying it to the soil."

Methods of Composting Garbage.

There are several methods of composting garbage. These include:—

(1) *Aerobic composting in piles.* This is a relatively cheap process, the main costs in addition to the preparation and grinding of the garbage being the turning operations. Piles may be made in the open or in covered bays.

(2) Patented processes using either *anaerobic fermentation in cells* (the Beccari process) *or forced aeration and bacterial inoculation in silos* (the Earp, Thomas and Frazer processes).

A plant of the latter type has been erected by the Municipality of Canterbury, Sydney, at a cost of approximately £125,000. The capacity of this plant is 100 tons of garbage per week producing 16 tons of compost.

The composting process is reported to take only two days. However, the resultant material cannot be termed "compost" since during the fermentation only partial decomposition would have occurred. Probably all this process is doing is to use the heat of fermentation to dehydrate the disintegrated garbage sufficiently to handle it and bag it for sale without rotting the bags. It would appear more economical to dry the garbage with hot air. The product would not be "compost" but would be no different in appearance or value to the partially fermented product.

These patented processes are not considered to have sufficient advantage over Aerobic composting in piles to justify the additional cost.

(3) *Dano process.* In this method the garbage is elevated without previous

sorting into a rotating horizontal cylinder. The garbage is kept well aerated by this tumbling process and is intimately mixed. Fermentation proceeds rapidly and the garbage dries out and becomes innocuous. The fermented garbage is hand picked for non-compostable material, then re-ground for disposal. The main disadvantages of this system are the high capital and running costs.

Difficulties in the Composting Process.

The following are considered to be the main difficulties to be found in composting garbage:—

(1) *Elimination of non-compostable material.* Many attempts to compost Municipal garbage have failed, mainly because of the difficulty of eliminating the non-compostable material. Mechanical methods to remove all the non-compostable materials have not been successful to date. Labour to carry out hand sorting of garbage would be difficult to obtain in this country, because of the distasteful nature of the work.

(2) *Mechanical troubles.* Mechanical breakdowns in garbage composting plants can cause costly and unpleasant delays, because of the accumulation of rotting and putrefying material. Duplication of plant avoids this trouble, but is very costly.

(3) *Disposal of non-compostable material.* The non-compostable material, unless of salvage value, would need to be dumped in a tip. Without the bulk of the compostable material it would not be a suitable material for filling a depression for subsequent use as a playing field, or park.

(4) *Health regulations.* The Garbage Composting area would be regarded as a Municipal tip by the Health Commission, which would involve the usual precautions against rats and flies, etc. It is probable that the compost pits would require to be covered.

(5) *Lack of suitable sites within the Municipality.* A large area of level ground is required for the erection of the treatment plant and suitable sites for composting would therefore be at least as hard to find as suitable tipping sites.

Victorian Experience.

Some Municipalities and Shires in Victoria have experimented with pilot garbage composting plants, but all these plants have been abandoned because of handling and mechanical worries, rat and fly infestation or difficulty in the sale of the product.

For example, the Mornington Shire Council composted garbage. The garbage was tipped as collected and mixed with 5% of animal manure. Intake was 30-40 cubic yards of garbage per week and there was little or no industrial waste. Screening was carried out by hand following composting.

The establishment at Mornington consisted of a front end loader, a screen and one man. The calculated handling charges are shown below:—

On site handling .	5/- per cubic yard
Screening	10/- per cubic yard
Total	15/- per cubic yard

The finished product was sold at £2/5/- per cubic yard (£3/10/- to £4 per ton), bagging and transport being additional charges.

The project was abandoned because the site was unsuitable and also because there was a poor demand for the finished product. This poor demand indicates that farmers are not interested in a compost which contains some non-compostable material. On the other hand, further screening of the compost would increase costs of production considerably.

Equipment Required for a Pilot Plant to Study Composting of Garbage.

The following pilot establishments can be used to study garbage composting:—

(1) For the production of sufficient pulverised garbage for experimental purposes the following equipment should be set up at a Municipal tip:—

(i) Chute to receive garbage.

(ii) Conveyor belt and hand labour to remove uncompostable material.
(iii) Hopper to receive compostable material.
(iv) A hammermill, or other grinding mechanism to pulverise the garbage.
(v) Site for compost pile and equipment for turning and bagging.

(2) For a small-scale plant to provide information for cost studies, and equipment design, i.e., a small-scale plant carrying out the full treatment process the following are required:—
(i) Receiving hopper.
(ii) Shaker or rotary screens.
(iii) Conveyor belt and hand labour.
(iv) Magnetic separator.
(v) Pulveriser.
(vi) Elevator.
(vii) Storage silo (optional).
(viii) Compost pile beds or maturing bins.
(ix) Screening and bagging equipment.

Present Methods of Garbage Disposal.

Garbage is disposed of either by dumping or by incineration in a destructor.

Dumping involves the transport of garbage to a tipping area where it is then covered with soil, sawdust or other filling material. Dumping sites are becoming scarcer in some of the inner suburbs and transport costs of garbage from these suburbs to other sites are high. The cost of filling material has also increased, but for most Municipalities this is still the most economical method of garbage disposal. There are sufficient tipping sites within the Melbourne Metropolitan Area to last for many years. When tips are filled they are used for playing areas or parks.

Where transport costs to a dumping site are high, *incineration in a destructor* may be a more economical form of garbage disposal. The disadvantages of incineration are—
(1) the initial high cost,
(2) the immediate surroundings are unpleasant, unsightly and associated with smoke odours, etc.,
(3) running costs are also high, and
(4) the ash must be disposed of.

Comparison of Composting With Present Methods of Disposal.

The following comparison of composting with the present methods of disposal namely dumping and incineration is made on the basis of (1) economic considerations and (2) health considerations:—

(1) *Economic considerations.* As the composting site would be treated as a tipping site, there would be no reduction in the expense of collecting, transport and tipping of the garbage at the treatment area. The cost of filling material and the costs of dumping of the non-compostable material would be estimated as being equal. Therefore, unless the garbage rates were increased the capital and operating costs of the composting plant would need to be paid from the sales of the compost to farmers. As stated earlier, farmers are not at present willing to pay a price which would cover the probable cost of production.

Municipalities which have found it necessary to erect incinerators because of lack of dumping sites, would also be lacking in sites for composting plants.

(2) *Health considerations.* It is probable that the composting site would be a greater risk than a tip from the health point of view because garbage falling from conveyor belts may be included with non-compostable material. The type of labour offering for hand sorting of garbage would not be reliable in taking care with material which can be a menace to health.

Sewage Sludge

Sewage sludge is the solid material deposited after detention of sewage in a settling or sedimentation tank.

In general, sludge may be divided into four classes, according to the method of treatment, namely:—

(1) *Primary sedimentation (raw) sludge.*

(2) *Secondary sedimentation sludge.* (i) Activated sludge. (ii) Humus sludge—following trickling filter.

(3) *Digested Sludge.* (i) Primary sludge. (ii) Secondary sludge. (iii) Mixed primary and secondary sludge.

(4) *Chemically Precipitated Sludge.*

Each of the above may be provided in one or other of the following forms:—

Wet sludge, containing approx. 96%—98% moisture.

Air dried sludge, containing approx. 10%—70% moisture.

Heat treated sludge, containing approx. 0%—10% moisture.

Raw sludge may be troublesome because of its grease content and the difficulty of applying it to the land without creating a nuisance from odours. It should be regarded as only one degree removed from nightsoil and treated accordingly.

Digested sludge is the type most commonly produced in this State.

Availability of Sewage Sludge in Victoria.

1. Metropolitan Area.

(i) *Raw sewage.* Raw sewage effluent is used by the Melbourne and Metropolitan Board of Works farm at Werribee to irrigate 25,000 acres of pasture for grazing cattle and sheep.

(ii) *Air dried digested sludge.* Economic quantities of air-dried sludge are not available in the Metropolitan area at the present time. In the event of partial treatment of all Melbourne sewage involving a reduction in the Biochemical Oxygen Demand to 250 p.p.m. with disposal of sludge by digestion and air-drying, approximately 40,000 tons of sludge, having a moisture content of 67%, would be produced per annum. A small quantity of this material, suitable only for experimental purposes, is available at Braeside.

(iii) *Partially air-dried and partially digested sludge.* At present, small quantities of this material are available at the Melbourne and Metropolitan Board of Works farm at Werribee, where it is occasionally used for filling of low lying areas.

2. Country Areas.

Thirty-four (34) sewage schemes have been or are being constructed in Victoria outside the Metropolitan area. These are classified below in accordance with the method of treatment used, and the probable availability of direct sewage sludge is indicated in each case.

(i) *No treatment and disposal to ocean* (3).

Geelong, Portland, Warrnambool — No sludge available.

(ii) *Partial treatment* (5). Sedimentation, sludge digestion and air drying followed by land disposal of the settled sewage.

Location	Estimated Dried Sludge per Annum
Bendigo	800 tons
Horsham	400 „
Murtoa	100 „
Swan Hill	400 „
Wangaratta	400 „

(iii) *Full treatment* (22). Sedimentation, sludge digestion and air drying, filtration, disposal of purified effluent on land, or to nearest watercourse.

Location	Estimated Dried Sludge per Annum
Ararat	350 tons
Bairnsdale	300 „
Ballarat	1,000 „
Castlemaine	350 „
Dimboola	100 „
Eildon	100 „
Hamilton	400 „
Kerang	200 „
Kyabram	150 „
Kyneton	200 „

Location	Estimated Dried Sludge per Annum
Leongatha	100 „
Maffra	100 „
Moe	450 „
Mornington	500 „
Morwell	300 „
Nhill	100 „
Shepparton	500 „
Traralgon	300 „
Warracknabeal	100 „
Warragul	300 „
Yallourn	150 „
Yarrawonga	150 „

(iv) *Full treatment* (5). Sedimentation, activated sludge, sludge digestion and air drying, disposal of final effluent on land or to nearest watercourse.

Location	Estimated Dried Sludge per Annum
Benalla	250 tons
Colac	400 „
Dandenong	500 „
Echuca	400 „
Mildura	500 „

The above figures indicate that the total output of dried sewage sludge in country areas could be placed at about 10,000 tons per annum, the maximum amount available at any one centre being about 1,000 tons per annum at Ballarat. No substantial increase is expected in the next five years, and the quantity is unlikely to be more than doubled within 25 years.

Quantities of raw sludge available could be placed at about twice the amounts quoted above.

Of the total annual output of 10,000 tons, about 2,000 tons is from activated sludge plants which produce a somewhat better quality sludge in terms of nitrogen and phosphorus. However, the scattered location of these plants (Benalla, Colac, Echuca, Dandenong and Mildura) would prohibit any combination of output. It is therefore considered that, as far as country areas are concerned the use of sludge for fertiliser manufacture must be based on normal sludge and not activated sludge.

In a few cases in Victoria, heated digestion tanks are in use, but these do not destroy pathogens as temperatures reached do not exceed 80°-90°F.

All sludge in Victorian country areas is air dried, and heat treatment of sludge is not used, or likely to be used in this State.

Manurial Value of Sewage Sludge.

The fertiliser value of dry digested sludge is low and it contains from 2%-3% of nitrogen, some phosphorus and little potash. Its manurial value is comparable with stable manure—about equivalent to that of an equal weight of horse or cow manure, but it is much slower in its action, as the nitrogen and phosphate are present in forms which are only slowly available to plants. Also, the physical effects of sewage sludge on the soil are less pronounced and of a different kind from those of farmyard manure, because sewage sludge lacks the coarse fibrous ingredients derived from straw and other plant residues.

The use of toxic materials in city industries is likely to increase in years to come and the concentration of these materials in sewage sludge could be toxic to plant growth. The use of detergents, some of which are known to be bactericides, may also raise a problem.

Health Considerations.

Raw sewage is an offensive and dangerous material in the hands of the public. The history of old Melbourne concerning the battle to eliminate cesspools and to control the indiscriminate use of night soil on the vegetable farms, is still clear enough to Public Health officers to discourage any return to such a state.

Melbourne sewage is quite safe after delivery to the Melbourne and Metropolitan Board of Works farm at Werribee.

Air dried sewage sludge is also a material which should not reach the hands of farmers, the reason being that the method of production and eventual

storage is a very variable process. The use of such material could not be controlled after it leaves the sewage farm.

Heat dried sewage sludge could be released to farmers with the permission of the Commission of Public Health, as heat treatment to a temperature of at least 145°F. is sufficient to kill pathological organisms, although a higher temperature may be required to kill parasitic ova.

There is at present no economical method for the chemical disinfection of sewage sludge.

Present Methods of Disposal.

Sewage, whether fully or partially treated in Victoria, is always disposed of on land where practicable. In areas where this is not practicable (Gippsland) the fully treated effluent is passed through sand filters and chlorinated before discharge to a watercourse.

Dried sludge is at present disposed of in a variety of ways, sometimes being used for filling.

Possible Methods of Using Sewage.

(1) *Composting raw, or air-dried sewage sludge with garbage.* Sewage sludge is composted with garbage in some parts of the world and it is claimed that the temperatures reached during the composting process are sufficiently high to kill all pathogenic organisms. One difficulty would be to supervise the process to ensure that all portions of the compost heap reached the lethal temperature for organisms, and the Commission of Public Health would not agree to the sale of such compost in this State.

(2) *Heat dried sewage sludge.* This is the only form of sewage sludge which can be used in Victoria for health reasons. Heat drying is a practicable procedure and it would appear that this material could be produced at the Werribee Sewage Farm and at some country centres.

"Wooltana No. 1," a fertiliser manufactured in South Australia, is said to be a mixture of heat dried sewage sludge, blood and bone and superphosphate. It would also be possible to use heat dried sludge for composting with straw, or garbage.

The cost of heat drying of sewage sludge is difficult to estimate, but would probably be much more than the price farmers would be prepared to pay for the material.

Transport from the site of treatment would be an additional cost which would limit the area on which the material could be used. For this reason also it would be preferable for farmers to purchase heat dried sludge and carry out composting on their own properties.

Recommendations

(1) The Sub-Committee cannot recommend to Municipalities that composting of garbage should be introduced or that any major change should be made in garbage, or sewage disposal. At the same time, the possibility of composting as a method of garbage disposal, and heat-treatment of sewage sludge as a method of sewage disposal should be kept in mind. These subjects might well be revived at a later date in the event of:—

(i) Market gardeners and orchardists indicating that they are prepared to pay for organic manures a price approximating to the cost of production of composted garbage, or heat-treated sewage sludge,

(ii) the introduction of heat-treatment of sewage sludge on a large scale,

(iii) the installation of digesters for the treatment of Melbourne sewage, which would greatly increase the quantity of sewage sludge available for disposal or

(iv) the introduction of grinding of garbage and disposal through the sewage system which would increase the quantity of organic material available for treatment in the sewage system.

(2) It was obvious during the studies of the Sub-Committee that there is little

factual information on the supply and demand position for organic manures. A detailed study of this subject was beyond the scope of this Sub-Committee. The Sub-Committee recommends therefore that such a study would be a worthwhile activity for the Australian Institute of Agricultural Science, in conjunction with other interested bodies, for example, The Institution of Engineers.

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(*Received for publication, August* 11, 1955).

NOTE.—Reprints of this article will soon be available from Mr. J. P. Brien, Honorary Secretary, Victorian Branch, Australian Institute of Agricultural Science, c/o The Victorian Department of Agriculture, Treasury Buildings, Melbourne, C.2. A nominal sum of 1/- each will be charged.

BOOK REVIEWS

HANDBOOK TO POULTRY PRACTICE

By KEITH WILSON

(*London, Poultry World,* 1954, 10/- *stg.*)

The book is aptly named and bears the unmistakable imprint of a teacher who is highly learned in his profession. The author has covered all phases of poultry farming in a complete and concise manner.

The book is devoid of padding and contains a fund of information for those interested in poultry. All information other than that on poultry buildings is applicable to flocks in Victoria.

Subjects dealt with are breeding, selection of stock, egg production and progeny testing. Selection and candling of eggs for incubation, natural and artificial hatching and principles of incubation.

Food values and analysis, feeding formulae, nutritive ratios, antibiotics and feed supplements are clearly defined.

The rearing, preparation and dressing of table poultry, surgical and hormone caponising, and ducks, turkeys, and geese all receive adequate attention.

The chapter on bookkeeping and records is of special merit, and makes this arduous task simple and attractive.

The modern system of laying cages which receives due consideration brings the book right up to date. A copy of this excellent work should be included in all poultry farming libraries.

MARTIN D. HALL.

EFFECT OF SOIL EROSION ON LAND VALUES AND PRODUCTION

By I. MOLNAR

Inadequate Australian experimental data limit the calculation of financial loss caused by soil erosion on farms to two methods. One method is the measurement of the extent of capital loss resulting from erosion by a comparison of the sale value in a given district, over a period of time, of non-eroded farms and farms which have been seriously eroded. The other method is to evaluate the loss in production on farms affected by soil erosion. The prerequisites for such studies are detailed soil and erosion maps. In Victoria these are available for 180 square miles in the Dookie district by Downes (1949) and for 70 square miles in the Coleraine district by Blackburn and Leslie (1949). Both districts are affected by water erosion.

Land Values

Data Used and Method of Computation

The amount of money paid on each land sale during the period 1935 to 1952 in the areas covered by the soil survey around Dookie, and during the period 1939 to 1953 in the areas covered by the soil survey around Coleraine, was obtained from the State Land Tax Department. The term "land" could have included improvements of various values and it may have been sold either as a whole farm or part of a farm. As far as could be determined, *bona fide* sales only were considered and sales below 50 acres were generally disregarded. Of the total number of sales, 63 were considered *bona fide* in the Dookie district and 64 in the Coleraine area.

For the purpose of this investigation the soil types were grouped by the respective soil surveyors into eight classes for the Dookie area, and into six classes for the Coleraine area. Number 1 soil class was allotted to the most fertile soil types, and for each piece of land sold the final class was determined by computing the weighted average of the various classes of which the area consisted. Then each piece of land, without regard to its soil class, was placed by the soil surveyor into one of five erosion classes, with number 1 class allotted to uneroded land. This classification was made according to the extent and degree of erosion (if any) on each property as a whole.

The validity of this investigation is not likely to be affected by the prices paid for land during the period of land sale control between February, 1942, and September, 1949, when land sales had to be made at prices prevailing on 14th February, 1942, because the aim was to determine the *differences* in the prices paid in any one year for areas of land which had been eroded to varying degrees, and not the actual price paid. It is likely that there has been only a relatively minor change in the state of erosion and its recognition by buyers of land in these areas over the periods for which land sale data were collected.

Findings of the Statistical Analysis

A study was made of the regression of price on an area of land sold, soil class and erosion class. To eliminate any inflationary effect from the per acre prices paid by the buyers over the periods considered, all comparisons were restricted to land sales within each year.

The findings of the statistical analysis are as follows:

(a) *Dookie Area.*

1. No significant association exists between the price and acreage of the land

I. MOLNAR, Ph.D. (Budapest), M.Agr.Sc. is Conservation Economist with the Soil Conservation Authority of Victoria.

sold. Furthermore, for land of the same soil class there is no significant association between the price and erosion class of that land.

2. Very highly significant association exists between price and soil class; 42.9 per cent. of the variation in price can be ascribed to this factor.

3. An increase in soil class number by one unit (i.e., decrease in fertility) corresponds to a decrease in price of about £3 per acre.

(b) *Coleraine Area*

1. The three factors: acreage, soil class, and erosion class are significantly and jointly associated with price.

2. 47.4 per cent. of the variation in price can be considered as being made up as follows: (i) 42.9 per cent due to acreage and soil class, and (ii) 4.5 per cent. due to erosion class, after allowing for variation due to acreage and soil class.

3. Provided that all three factors contributing to the price of an area of land sold are simultaneously considered, it is estimated that: (i) an increase in the acreage of the land by 10 acres corresponds to a decrease in price of about 2s. 6d. per acre; (ii) an increase in soil class (i.e., decrease in fertility) by one unit corresponds to a decrease in price of about £5 per acre; (iii) an increase in erosion class by one unit corresponds to a decrease in price of about £1/10/- per acre.

Production

Data Used and Method of Computation

Farmers were interviewed in the 180 square mile area around Dookie during the latter part of 1953 and information concerning production was collected for the years of 1951 and 1952. Out of the total number of 131 farms within this area, covered by soil and erosion maps, 57 farms (44% of the total number) proved to be suitable for the investigation. The others had to be omitted because parts of the farm were outside this mapped area, no adequate or reliable information could be provided by the farmer, the area or the management of the farm changed during 1951-2, and a relatively small number were omitted for other reasons.

The investigation of the effects of erosion on wool and lamb production and on the rate of stocking was based on two years' average production and stocking rate data, soil class and erosion class. The method of computation was as follows:

(i) *Wool production per acre* was adjusted for cattle held on the farm, hand feeding, fodder purchases or fodder production on the farm, sales and purchases of sheep before shearing, and wool shorn off lambs. This last adjustment put farms not producing fat lambs on the same footing as those producing fat lamb plus wool, i.e., farms from which the lambs are usually sold unshorn. Quality differences could not be taken into account.

(ii) *Lamb production per acre* was arrived at by dividing the number of lambs sold by the total farm area. Differences in quality had to be ignored.

(iii) *Improved pastures* were used without regard to the fertilized area because on most farms the bulk of the area under improved pastures was fertilized and in most cases there was little variation in the amount of superphosphate used per acre.

(iv, v) *Top-dressed native pastures and non-fertilized native pastures* were taken into account separately but on the former type of pasture, similarly to improved pasture, the amount of superphosphate used per acre was disregarded.

(vi) *Rate of stocking* (as acres per dry Merino sheep) was calculated from the number and types of stock at 31st March each year, and the date of stock movements on and off the farm during the two year period. The units used for conversion were those calculated by Lang *et al.* (1952), and adjustments were made for hand feeding.

(vii, viii) *Soil and erosion class* of each farm were determined by the soil surveyor in the same way as for the cal-

culation of the effect of erosion on land values described previously.

Findings of the Statistical Analysis

A study was made of the regression of wool production, fat lamb production, rate of stocking on improved pasture, top-dressed native pasture, soil class and erosion class. The production attributable to non-top-dressed native pasture was so small as to be of no statistical significance and was omitted from all calculations.

The findings of the statistical analysis are set out hereunder and in Table I.

(a) *Wool Production*

1. The three factors, improved pasture, top-dressed native pasture, and erosion class are significantly and jointly associated with wool production. The soil class factor has no significant effect on wool production.

2. 48.4 per cent. of the variation in wool production can be considered as being made up as follows: (i) 38.6 per cent. due to the combined percentages of the farm area under improved pasture and top-dressed native pasture; and (ii) 9.8 per cent. due to erosion class, after allowing for variation due to improved pasture and top-dressed native pasture percentages.

(b) *Lamb Production*

1. The two factors, percentage of improved pastures and erosion class are significantly and jointly associated with lamb production. The soil class and native pasture percentage factors have no significant effect on lamb production.

2. 29.3 per cent. of the variation in production can be considered as being made up as follows: (i) 19.1 per cent. due to the improved pasture percentage; and (ii) 10.2 per cent. due to erosion class, after allowing for variation due to the percentage of improved pasture.

(c) *Stocking Rates*

1. The four factors, percentage of acreage of improved and top-dressed native pasture, soil class, and erosion class are significantly and jointly associated with stocking rates.

2. 43.9 per cent. of the variation in stocking rates can be considered as being made up as follows: (i) 28.4 per cent. due to the improved pasture and top-dressed native pasture percentages and

TABLE 1

The effects of increased acreage of types of pasture (as per cent. of the farm's area) and erosion and soil classes on the production and stocking rates of farms around Dookie.

Increase equal to:	Effect *throughout* the farm on:		
	Wool production per acre	Lamb production per acre	Stocking rates as acres per dry Merino sheep
10% improved pasture	+0.49 lb.	+0.04 lamb	—0.11 acres
10% top-dressed native pasture	+0.44 lb.	*	—0.11 acres
1 unit erosion class	—0.66 lb.	—0.06 lamb	+0.18 acres
1 unit soil class	—	—	—0.28 acres†

*Lack of effect is due to the measurement of lamb production in terms of numbers of lambs per acre and not in weight of lambs per acre.

†Farms with soils in the better classes were used mainly for cultivation and carried relatively small numbers of sheep. (Increase in soil class means decrease in fertility).

soil class; and (ii) 15.5 per cent. due to erosion class, after allowing for variation due to the improved pasture and top-dressed native pasture percentages and soil class.

Discussion

In the Dookie area when a comparison is made of the sales of two areas of land, one of which falls into the best soil class and the other into the worst, the difference in the two prices can be expected to be about £21 per acre, regardless of the degree and extent of erosion or the size of the lands. In the Coleraine area, however, when comparing two areas of land sold in any one year, the size and erosion class of the two areas being comparable, the difference in prices between the best and worst soil classes can be expected to be about £25 per acre. This figure can be compared with £27/9/- and £65/9/-, the lowest and highest prices respectively paid for lands per acre in the Coleraine area in 1952, and used in the present statistical analysis. The significant association between size of the land and the price paid per acre for it in the Coleraine area is likely to be associated with the larger proportion of dairying on the relatively smaller sized holdings than on the larger ones.

The effect of erosion on land values in the Coleraine area, although small, can be ascribed to the more spectacular types of erosion, namely land slides, silt deposition on the river flats, accompanied by gullies and sheet erosion. In the Dookie area, however, where only sheet erosion and gullies occur, land values are not affected adequately by these types of erosion.

In the Dookie area, the difference in production between two successive erosion classes is about 0.66 lb. wool and about 0.06 lamb per acre per year; hence the difference in production between non-eroded and the worst eroded farms is estimated at 2.64 lb. wool and 0.25 lamb per acre. In terms of money at 1948/49-1951/2 average price*, the value of these products is about £1/10/- per acre per year. Assuming that two-thirds of this amount is production costs, then 10s. net income capitalized say at 4 per cent. gives the sum of £12/10/- per acre, as the approximate difference in value between a non-eroded and the worst eroded farm on account of wool and lamb production only. (Since increased production does not necessarily increase the production costs correspondingly, this sum is likely to be an underestimation). The additional difference in value on account of likely lower cereal yields or lower quality of lambs on the eroded farms could not be calculated because of lack of data. Nor could value be put on the greater likely loss in production in drought years on eroded farms.

*Wool: 56's 71.32d. per lb.; Fat lamb (39 lb.) £3.

Conclusion

Although buyers of land in the Dookie area have not given adequate attention to erosion, the wool and lamb production of eroded farms in this area was found significantly lower than of the non-eroded ones. It is considered that the absence of effect of erosion on land values is not attributable to differences in the profitability of production over the periods used for the study of land values. The lack of a comparable difference in land purchase values indicates that sheet erosion is still not adequately recognized by the farmers around Dookie and there is a lack of attention to erosion even when it is severe enough to result in considerable loss of production.

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A PRELIMINARY SURVEY OF PLANT NEMATODES IN QUEENSLAND

By R. C. COLBRAN

Summary.

In addition to the root-knot nematodes, *Meloidogyne javanica* (Treub) Chitwood *M. incognita* (Kofoid and White) Chitwood and *M. incognita* var. *acrita* Chitwood, plant parasitic nematodes which occur in Queensland include the citrus nematode, *Tylenchulus semipenetrans* Cobb, the root-lesion nematodes, *Pratylenchus coffeae* Zimmerman, *P. zeae* Graham, *P. brachyurus* Godfrey, the chrysanthemum eelworm *Aphelenchoides ritzema-bosi* (Schwartz) Steiner, the burrowing nematode, *Radopholus similis* (Cobb) Thorne, the spiral nematodes, *Rotylenchus erythrinae* Zimmerman and *R. multicinctus* (Cobb) Filipjev, the pin nematode, *Paratylenchus macrophallus* (de Man) Goodey, and a stubby-root nematode, *Trichodorus* sp.

Introduction

There are few records dealing with nematode investigations in Queensland and the majority are the result of field trials concerned with the control of the root-knot nematodes, e.g., Haney (1950); Smith (1954). Illingsworth (1920) reported the association of *Tylenchus sp.* with root rot of bananas (*Musa spp.*) in North Queensland. From his description, it is evident that the species concerned is *Radopholus similis* (Cobb) Thorne. Colbran (1953, 1954) published two papers dealing with *Pratylenchus coffeae* Zimmerman in relation to the apple replant problem at Stanthorpe, and recorded other species in these papers and in notes to the Australian Plant Disease Recorder (unpublished).

Nematodes Associated with Underground Plant Parts

Root-knot Nematodes (Meloidogyne species)

The root-knot nematodes are the most widely distributed and important group of plant parasitic nematodes in Queensland. Crop plants attacked include pineapple (*Ananas comosus* (L.) Merr.), bananas (*Musa spp.*), tobacco (*Nicotiana tabacum* L., papaw (*Carica papaya* L.), potato (*Solanum tuberosum* L.), sugar cane (*Saccharum officinarum* L.), tomato (*Lycopersicon esculentum* Mill.), carrot (*Daucus carota* L.), lettuce (*Lactuca sativa* L.), pumpkin (*Cucurbita pepo* L.), maize (*Zea mays* L.), French bean (*Phaseolus vulgaris* L.), cowpea (*Vigna sinensis* (L.) Endl. ex Hassk.) and passion fruit (*Passiflora edulis* Sims). Root-knot is common on a number of plants in virgin forest and severe losses may be experienced by the first susceptible crop planted on these areas.

A study of the root-knot nematodes present in Queensland is now being undertaken, and it has been found that the predominant species are *M. javanica* (Treub) Chitwood, *M. incognita* (Kofoid and White) Chitwood and its variety *M. incognita* var. *acrita* (Chitwood). Races under investigation differ in host range from those of the same species used by Sasser (1954), who proposed an identification system on host-parasite relationships. Martin (1954) has also found that there are different parasitic races of these species.

Root-lesion Nematodes (Pratylenchus species)

Three species of root-lesion or meadow nematodes are known to occur in Queensland, viz., *P. coffeae* Zimmerman, *P. zeae* Graham and *P. brachyurus* Godfrey.

R. C. COLBRAN, M.Agr.Sc. is an Entomologist with the Queensland Department of Agriculture and Stock.

P. coffeae is responsible for a replanting problem in old apple orchards at Stanthorpe where tree dieback follows the destruction of the fibrous roots and young extension roots (Colbran 1953). This species has been found to reproduce also in the roots of the following plants:—corn spurry (*Spergula arvensis* L.), common sowthistle (*Sonchus oleraceus* L.), flatweed (*Hypochoeris radicata* L.), lesser swinecress (*Coronopus didymus* (L.) Sm.), cabbage, cauliflower, broccoli (*Brassica oleracea* L.), prairie grass (*Bromus catharticus* Vahl), couch grass (*Cynodon dactylon* (L.) Pers.), summer grass (*Digitaria adscendens* (H.B.K.) Henrard), Wimmera ryegrass (*Lolium rigidum* Gaud.), English walnut (*Juglans regia* L.), N.Z. blue lupin (*Lupinus angustifolius* L.), garden pea (*Pisum sativum* L.), red clover (*Trifolium pratense* L.), linseed (*Linum usitatissimum* L.), sorrel (*Rumex acetosella* L.), Japanese quince (*Cydonia oblonga* Mill.), apricot (*Prunus armeniaca* L.), Peach (*Prunus persica* Batsch), Japanese plum (*Prunus salicina* Lindl.), pear (*Pyrus communis* L.), and grape (*Vitis* spp. L.).

P. brachyurus has been obtained from lesions on pineapple roots in plantations at Yeppoon, Nambour, Mackay and Brisbane. It appears to be associated with areas of poor growth but the importance of this species has yet to be assessed. *P. brachyurus* has also been found in association with the roots of the following plants—white clover (*Trifolium repens* L.) and red clover at Kybong; mung bean (*Phaseolus mungo* L.) at Ormiston; avocado (*Persea americana* Mill.) at Ormiston; hoop pine (*Araucaria cunninghamii* D. Don) at Benarkin.

P. zeae is associated with peach tree decline at Pinkenba. The trees show typical symptoms of root-lesion nematode damage, namely scarcity of functional feeding roots and dieback of branches. This species has also been found in lesions on sugar cane roots at Eight Mile Plains.

Citrus Nematode (Tylenchulus semipenetrans Cobb)

T. semi-penetrans has been found on *Citrus* spp. in all important citrus-growing areas of Queensland and has also been obtained from the roots of olives (*Olea europaea* L.) at Lawes.

Burrowing Nematode (Radopholus similis (Cobb) Thorne)

R. similis has been found in lesions within banana roots in the Gilston, Maroochy and Cairns-Tully areas. This nematode appears to be the primary pathogen responsible for banana root rot, a disease which is most prevalent in North Queensland. Affected stools show "bunched throat" and considerable root decay. Longitudinal sections of the roots show discoloured lesions within the cortex but no discolouration of the stele. *R. similis* has also been found within lesions on the roots of *Musa banksii* F. Muell., a native banana which grows in the rain forests of north Queensland.

Spiral Nematodes (Rotylenchus species)

R. erythrinae Zimmerman is very common in the soils of coastal Queensland, being found in association with the roots of a number of crop plants. It is present in most pineapple plantations and has also been found in soil washed from the roots of macadamia nut (*Macadamia ternifolia* F. Muell.), avocado, sugar cane, citrus and tomato. In most situations it appears to be ectoparasitic in its habits although it has been found coiled within the cortex of barley (*Hordeum vulgare* L.) at Stanthorpe.

R. multicinctus (Cobb) Filepjev has been obtained from surface lesions on banana roots in the Maroochy district.

Pin Nematodes (Paratylenchus species)

P. macrophallus (de Man) Goodey has been reported from soil near the roots of sorrel at Applethorpe (Colbran 1954).

Dagger Nematodes (Xiphinema species).

A large number of specimens of *X. americanum* Cobb were found in soil ad-

hering to avocado roots at Sunnybank. *X. campinense* Lordello occurs in a banana plantation at Gilston.

Ring Nematodes (*Criconemoides species*)

C. lobatum Raski occurs in soil about the roots of dahlias (*Dahlia spp.*) in the Brisbane Botanical Gardens, and an unidentified species has been collected from an area of white clover at Samsonvale.

Stubby-root Nematodes (*Trichodorus species*)

An undescribed species of *Trichodorus* was reported by Colbran (1954) in association with tomato roots at Applethorpe. The same species has been obtained also in soil adhering to the roots of Sesbania pea (*Sesbania aculeata* Poir.) at Coolum and sugar cane at Brisbane. Males of this species have not been found.

All stages of *Tylenchus costatus* de Man and *Aphelenchoides bicaudatus* Imamura have been found in the root cortex of N.Z. blue lupins at Applethorpe. The two facultative parasites, *Aphelenchus avenae* Bastian and *Aphelenchoides parietinus* (Bastian) Steiner, are common in Queensland soils but in no instance could plant disease be attributed to their presence.

Nematodes Associated with Aboveground Plant Parts

The chrysanthemum eelworm (*Aphelenchoides ritzema-bosi* (Schwartz) Steiner) is present on chrysanthemums (*Chrysanthemum morifolium* Ramat.) in most districts of the State. It has been responsible for severe losses to commercial growers.

The nematode described by Currie (1937) as *Anguillulina* (*Fergusobia*) *tumifaciens* and renamed *Anguillulina* (*Fergusobia*) *curriei* by Johnston (1938) is common in eucalypt galls associated with flies of the genus *Fergusonina* Mall.

Acknowledgment

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MANGANESE EXCESS IN PEACH TREES

By P. BAXTER

Summary

Excessive uptake of manganese by peach trees has followed the acidification of a typical Goulburn Valley loam through repeated applications of sulphate of ammonia. Leaf symptoms of excessive manganese in Golden Queen Peach trees are described. Leaf manganese content was directly related to the H ion concentration of the soil.

Fruit yields were not affected and the application of lime prevented re-appearance of leaf symptoms.

Introduction

Manganese is an essential element for plant growth which, if taken up by plants in excessive quantities, can reduce growth and produce a variety of symptoms in many crop and pasture plants. Manganese can occur in various forms in the soil of which only the bivalent (reduced) compounds are soluble and easily taken up by plants. As acidity favours reduction, acid soils contain more soluble manganese but other factors, such as the forms of organic matter present, the soil microflora and soil moisture may all influence the solubility of soil manganese. (Leeper, 1947; Russell, 1950, p. 466).

While a deficiency of manganese occurs in many parts of Australia, symptoms due to excessive uptake of manganese have only rarely been reported in this country, namely, for grasses and wheat in New South Wales (Guthrie and Cohen, 1910), for lucerne at Canberra (Kipps, 1947) and for beans in New South Wales (Parbery, 1943) and in Queensland (Fergus, 1954). In Northern Victoria magnesium deficiency often occurs with excess manganese in citrus groves on light soils which have been acidified by repeated applications of sulphate of ammonia.

Peach trees have grown and yielded normally with as much as 300 ppm Mn in the leaf (Epstein and Lilleland, 1942) and the only previous record of manganese toxicity in peaches is that of Thornberry (1950) who describes bark lesions but no leaf symptoms.

The following investigations were carried out on Golden Queen peaches at the Horticultural Research Station, Tatura. The trees are growing on a typical soil of the western Goulburn valley irrigation area, forming part of the red brown earth zone of Victoria (Penman, 1936). In the virgin state, about 9 in. of slightly acid brown loam overlies slightly alkaline red brown clay. Lime occurs below 30 inches.

Tree Symptoms

An interveinal chlorosis, similar to symptoms typical of manganese deficiency in fruit trees, developed on leaves later shown to contain excessive amounts of manganese. On some trees leaves developed a marbled or blotchy chlorotic pattern. Many affected leaves showed an inrolled leaf margin with a red edge and small red spots on the leaf surface. Trees containing excessive quantities of manganese generally made less annual growth.

Leaf Analyses

Leaf analyses revealed an abnormally high manganese content in affected trees (see Table I).

Where the total manganese content of the leaf was below 600 ppm, no abnormal leaf symptoms were observed.

Survey of the Manganese Status of a Peach Manurial Trial

The fertilizer trial on Golden Queen peaches at the Horticultural Research Station, Tatura, consists of 6 replica-

P. BAXTER, B.Agr.Sc., is an Horticultural Research Officer with the Victorian Department of Agriculture.

TABLE I.

Leaf analyses in healthy and affected trees.

Condition	N%	P%	K%	Ca%	Mg%	Mn ppm
Healthy	3.57	0.30	3.04	1.50	0.49	134
Mildly affected	1.90	0.30	2.94	1.28	0.79	787
Severely affected	—	0.31	3.11	2.02	0.68	1350

tions of 8 treatments receiving N (as sulphate of ammonia) at 2 levels, P (as superphosphate) and K (as sulphate of potash) in various combinations. The trees were planted in 1937 and fertilizer applications commenced in 1944.

A rapid colorimetric leaf analysis for manganese using formaldoxime (Plant et al, 1944) was used to survey the manganese content of the trees in this trial.

Peach leaves were selected in November, 1952, from the first fully expanded leaves on new shoots. These leaves were macerated in a food grinder and extracted with Morgan's reagent. The colour developed on addition of formaldoxime was compared with solutions of known manganese concentration. Duplicate samples usually varied by less than 10% of their mean.

The manganese content of the leaves, as determined by the above method, varied from 2-55 ppm. These values correspond well with the total manganese content as determined by ash analysis (see Table II).

TABLE II.

Relation of Tissue Test Manganese to Total Manganese.

Symptoms	Mn Tissue Test ppm	Total Mn Dry Basis ppm
Severe	55	1353
Mild	22	675
Mild	18	725
None	9	352
None	less than 5	95

Discussion

Yearly applications of sulphate of ammonia ($3\frac{1}{2}$ and 7 cwt. per acre) for about 8 years have changed an originally slightly acid Goulburn Valley soil to a pH ranging from 4.5 to 6.0. Leaf sprays with sulphur compounds may also have contributed to the acidification of the soil. Increasing acidity has converted enough soil manganese into soluble forms to cause an excessive uptake of manganese by peach trees growing on this soil type. The direct relation between leaf manganese and soil acidity is shown clearly in Figure 1 while Table III shows that different level of applied N, P and K had no direct effect on manganese uptake.

Heavy rain or irrigation had no measurable effect on the uptake of manganese

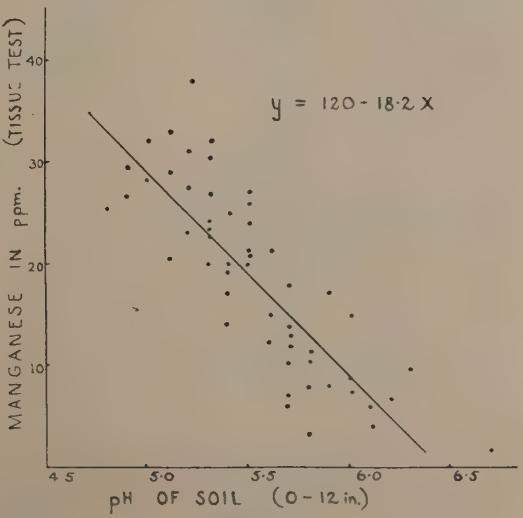

Figure 1.
Relationship between leaf manganese and soil acidity.

by peach trees but Table IV shows a seasonal variation in the manganese content of peach leaves for which no explanation can as yet be offered.

Excessive uptake of manganese has not yet been observed on commercial orchards in the Goulburn Valley area. Where it occurs, the obvious treatment is to apply lime to revert the soluble manganese into less available forms. At the Horticultural Research Station, Tatura, lime was applied to half the peach block to raise the soil pH to 6.0 and this has eliminated the re-appearance of leaf symptoms in subsequent years.

Acknowledgment

Plant ash and soil analyses were carried out by the Chief Chemists' Branch, while officers of the Horticultural Research Station, Tatura, assisted in the sampling and preparation of the leaf samples. Their help is gratefully acknowledged by the author.

TABLE III.

Relation of Leaf Manganese to Fertilizer Treatment.

Fertilizer	Leaf Mn ppm (tissue test)	Soil pH 0-12 in.
N_1	14.8	5.8
N_1, P	16.3	5.6
N_1, P, K	13.3	5.8
N_1, K	16.8	5.6
N_2	22.0	5.5
N_2, P	21.5	5.4
N_2, P, K	24.2	5.2
N_2, K	25.6	5.1

Each value is the mean of 4 trees.
N_1 = Sulphate of ammonia 3 lb per tree.
N_2 = Sulphate of ammonia 6 lb ,, ,,
P = Superphosphate 4 lb ,, ,,
K = Sulphate of potash 4 lb ,, ,,

Summary of Means

(1) pH N_1 = 5.68
N_2 = 5.29
Diff = 0.39; Significant at 1% level.

(2) Mn N_1 = 15.18
N_2 = 23.32
Diff = 8.14; Significant at 1% level.

TABLE IV.

Seasonal Changes of Leaf Manganese. Tissue Tests.

Date	High Mn Trees (3) ppm	Low Mn Trees (2) ppm
21/11/52	51	22
25/11/52	31	17
28/11/52	29	17
19/12/52	28	17
26/ 1/53	38	26
4/ 3/53	46	30
1/ 4/53	50	30
21/ 4/53	45	27

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THE FERTILITY STATUS OF SOME KYOGLE SOILS AND ITS RELATION TO THE SOIL PARENT MATERIAL

By J. W. McGARITY and D. N. MUNNS

Summary.

Five soils showing a range of morphological, chemical, and mineralogical properties, from the Kyogle district of New South Wales, were tested for nutrient deficiencies in pot trials using subterranean clover. Responses to either sulphur or phosphorus, or both, were obtained.

The chemical and mineralogical properties as a whole, while perhaps valuable as indicators of the long term fertility status of these soils, are unrelated to the initial fertilizer responses. The initial responses on these soils are better related to the proportion of basalt and sandstone in the soil parent materials, a knowledge of which appears to offer a rapid and more useful means of prediction of fertilizer requirement.

Introduction

Immediately west of Kyogle and Casino on the North Coast of N.S.W., the low and uneven productivity of natural pastures presents a serious problem, especially for dairying. As a guide to fertilizer requirements for the establishment of improved pastures, pot experiments were carried out on five freely-drained, and previously unfertilized sedentary and colluvial soils similar to those used for grazing over most of the area.

These soils showed a range of morphological, chemical and nutritional properties, which appeared to be related to their derivative parent material. In order to confirm this relationship, mineralogical studies were undertaken on each soil.

The Natural Environment of the Soils

The soils were, as far as possible, representative of some 200 square miles of hilly country between Kyogle and Casino in the east and the Richmond Range in the west. The richer alluvial soils of the flats were excluded from consideration.

The rainfall of this area is approximately 38 inches per annum with summer incidence.

The geology is uncomplicated; Tertiary basalt overlies horizontally bedded Jurassic sandstone, much of which had been weakly lateritized before the extrusion of the basalt flows. Subsequent dissection, however, has exposed the sandstone in many places, and all stages in the removal of the basalt cappings of the hills can be seen. Hence the parent material of the sedentary and colluvial soils may be derived from a mixing of the basalt and sandstone in varying proportions, ranging from sandstone alone to basalt alone. This gives rise to a gradation in the morphological soil properties.

Profile Descriptions of the Soils

The field descriptions of these previously undescribed soils are given below. The Munsell colour notation refers to the air dried sample. The exact location of each soil may be obtained from the military map reference (Australian Army Survey—scale 1 inch to 1 mile) enclosed in brackets under locality heading.

F.7 *Normal Chocolate Soil* (Hallsworth et al, 1952).

Locality and Environment. Woodview (Tabulam 067.208). Basalt; on flat hilltop carrying paspalum pasture. Cleared for 50 years.

Morphology.

A_1 0-6", dark brown (7.5 YR 3/2) friable clay loam, basalt floaters increasing with depth; pH 5.2.

AB 6-12", dark brown (7.5 YR 4/2) heavy clay loam; pH 5.4.

J. W. McGARITY, B.Sc.Agr., is Lecturer in Agricultural Chemistry at the University of Sydney and D. N. MUNNS is Assistant Analyst in the Chemists' Branch of the New South Wales Department of Agriculture.

B_2 12-24″, yellowish brown (10 YR 5/4) heavy clay loam; pH 5.6.

BC 24-36″, brown (10 YR 5/3) (faintly mottled red), heavy clay loam; pH 5.8; passing into decomposing vesicular basalt.

F2. *Normal Chocolate Soil* (Hallsworth et al, 1952).

Locality and Environment. Ettrick (Bonalbo 065.475). Basalt and sandstone on middle slope with Axonopus-paspalum pasture. Cleared 40 years.

Morphology.

A_1 0-6″, dark brown (10 YR 3/3) sandy clay loam with basalt floaters; pH 5.6.

AB 6-12″, dark greyish brown (10 YR 3.5/2.5) sandy clay loam to sandy clay, pH 5.5.

BC 12-18″ brown (10 YR 4/3) clay loam to clay, pH 5.4; passing into weathered basalt and sandstone floaters.

F.5 *Amphi-Podzol** (Hallsworth et al, 1953).

Locality and Environment. Ettrick (Bonalbo 065.419). Sandstone, mixed with basalt from eroded capping; recently cleared upper slope; natural pasture.

Morphology.

A_1 0-6″, dark grey (10 YR 4.5/1) sand; pH 5.4.

A_2 6-16″, grey (10 YR 5.5/1) sand; pH 5.7.

AB 16-20″, light brownish grey (10 YR 6/1.5) sand; pH 5.9.

B_2 20-24″, mottled yellow and grey (10 YR 7/4) gritty and sandy, clay loam to clay; pH 5.0.

BC 24-36″, red, yellow and grey mottled sandy clay passing into weathered sandstone; pH 4.6.

F.1 *Amphi-Podzol* (Hallsworth et al, 1953).

Locality and Environment. Ettrick (Bonalbo 039.424). Ferruginous sandstone; cleared upper slope.

Morphology.

A_1 0-6″, brown (10 YR 5/3) sandy loam; pH 5.2.

A_2 6-18″, light yellowish brown (10 YR 6/4-6/5 sandy loam; pH 5.1.

B_1 18-26″, strong brown (7.5 YR 5/8) sandy clay loam; pH 4.8.

B_2 26-36″, red and yellow-grey mottled (5 YR 5/8) sandy clay loam with ironstone fragments; pH 4.7.

BC 36-48″, red, yellow-grey and grey, fine mottled (5 YR 5/8), clay loam; pH 4.3, grading into

C 48-72″, red and white mottled (2.5 YR 5/6) clay loam; pH 4.0.

F.4 *Amphi-Podzol* (Hallsworth et al, 1953).

Locality and Environment. Ettrick. Adjacent to F.5. Sandstone on middle slope; natural pasture.

Morphology.

A_1 0-3″, greyish brown (10 YR 5/2) sand; pH 5.6.

A_2 3-12″, pale brown (10 YR 6/3) sand; pH 5.3.

AB 12-26″, light yellowish brown (10 YR 6/4) sand; pH 5.4.

B_2 26-48″, yellow and orange mottled (10 YR 7/6-7.5 Y 6/7) sandy clay loam; pH 4.7.

B_2g 48-60″, grey, orange and yellow mottled (10 YR 7/8) heavy sandy clay loam; pH 4.8, passing into

C 60-70″, light pinkish-grey mottled (7.5 YR 7/3), sandy and gritty clay loam; pH 5.0.

Experimental

1. *Sampling*

The sample of surface soil (0-6″) from each site was compounded from 9 subsamples which were taken on a rough grid covering 2-3 square chains.

2. *Chemical Analyses*

The methods of Piper (1942) were used.

*Corresponds to red-yellow podzolic of American pedologists.

3. *Mineralogical Examination*

This was carried out on fine sand fractions obtained from the dispersion of 100 grams of soil. Sesquioxide coatings were removed by the dithionite cleaning method of Aguilera and Jackson (1953). For the separation of the "light" and "heavy"* fractions and the microscopic identification of "heavy" minerals, the methods of Milner (1940) were followed. The minerals of the "light" fraction were identified by the staining methods of Hawkins and Graham (1951).

4. *Nutrient Trials*

Inoculated seedings of subterranean clover were planted into glazed, sealed, earthenware pots containing equal amounts of the test soils. The nutrients were added as solutions of the A.R. salts. The plants were then grown in the glasshouse to maturity, when the tops were harvested, dried and weighed. The pots were kept watered to field capacity with distilled water and randomized at frequent intervals to overcome position effects.

Two sets of trials were carried out, namely:—

*Separation by bromoform, sp. gr. 2.8.

Series 1. Modified Anderson type trials (Anon, 1952) were carried out on all five soils, using 12 seedlings of early strain sub. clover per pot. The rates of application in the "full" treatment of all elements are shown in Table I.

Due to lack of glasshouse space, certain elements were paired and the experiments were carried out in duplicate only. The treatments are listed below:—

Full treatment (for nutrient elements see Table I).
Full treatment—P.
Full treatment—KS.
Full treatment—Ca, Mg.
Full treatment—Mo.
Full treatment—Cu, Zn.
Full treatment—Mn, B.
Full treatment + lime (limed to soil paste pH 6.5).
Nil treatment.

Series 2. A duplicated factorial experiment was carried out with Cu, Zn, K and S each at two levels, in order to separate the effects of these elements for the soil F.7. Mount Barker sub. clover was used in this trial with 4 plants in smaller pots. Otherwise the procedure was the same as in the earlier trials.

TABLE I.

Rate and method of application of individual nutrient elements in "full" treatment.

Nutrient	Method of Application*	Equivalent commercial rate per acre.
P	Sodium phosphate	10 cwt. super
Mg	Magnesium chloride	56 lb. $MgSO_4$
Ca	Calcium carbonate	2 cwt. lime
K, S	Potassium sulphate	1½ cwt. K_2SO_4
Mo	Ammonium molybdate	4 oz. MoO_3
Cu	Copper chloride	7 lbs. $CuSO_4$
Zn	Zinc chloride	7 lbs. $ZnSO_4$
Mn	Manganese chloride	14 lbs. $MnSO_4$
B	Borax	3½ lbs. borax

*Calcium carbonate applied in suspension, remainder in solution.

TABLE II.

Mineralogy of the fine sand fraction.

Mineral species	Soils in order of decreasing basalt influence				
(a) % of "Heavy" Fraction	F.7	F.2	F.5	F.1	F.4
Opaques*	10	62	42	55	50
Rutile	8	13	24	21	21
Zircon	1	11	23	16	24
Tourmaline	—	4	3	5	2
Staurolite	—	1	3	2	1
Garnet	—	1	—	—	—
Monazite	—	2	5	—	3
Augite	78	1	1†	—	—
Olivine	3	—	—	—	—
% of fine sand (wt.)	1.24	1.30	.92	.26	.47
(b) % of "Light" Fraction					
Plagioclase	51	9	5	4	—
Orthoclase	4	2	1	1	—
Quartz	30	89	94	95	100
Biotite	15	—	—	—	—
(c) % of Soil					
Fine Sand	34	4	5	9	12
Total Sand	39	44	86	87	87

*Ilmenite, magnetite, leucoxene.

†2 grains in a count of 320.

Results and Discussion

1. *Mineralogical Data*

In Table II the soils are listed in order of decreasing basalt influence and increasing sandstone influence from F.7 to F.4 as postulated from field evidence. The data in the Table support this field interpretation of the sources of parent material, the chief diagnostic feature being the percentage of augite, which is derived essentially from the basalt. The quantity of augite is extremely high in soil F.7, whereas in F.2 and F.5 its presence in an otherwise sedimentary suite of minerals confirms a mixing of basalt with sandstone.

Most striking also, is the large proportion of minerals of recognised nutrient value in the basaltic soil F.7. Of these, augite, plagioclase and biotite are the most important. In soils F.2 and F.5 these minerals derived from basalt are masked by the high input of resistant mineral species, e.g., quartz, from the sandstone. The soils derived from sandstone alone (F.1 and F.4) are poor in nutrient minerals containing mostly species resistant to weathering.

2. *Chemical Data*

The chemical data are listed in Table III, where the percentage quartz in the fine sand fraction is used as an index of expected decreasing fertility. Good agreement is found with those chemical properties generally regarded as indicative of fertility status. This is somewhat similar to the findings of Hawkins and Graham (*op. cit.*) who obtained good agreement between the quartz content of silt fractions and the chemical data re-

TABLE III.

Analytical data for five Kyogle soils (oven dry weight basis.)

Soil	% Quartz in fine sand	Exchange Capacity*	Exchangeable Ions*		pH	% Silt	% Clay	% Available Moisture†	% Nitrogen	Phosphorus (p.p.m.)	
			Ca+Mg	K						Available	Total
F.7	30	37	17.1	1.38	5.2	22	30	12.5	.271	5.7	545
F.2	89	29	10.9	.30	5.6	12	35	8.2	.183	Trace	578
F.5	94	8	6.0	.26	5.4	3	8	2.4	.125	10.1	191
F.1	95	7	3.6	.03	5.2	6	9	1.6	.032	8.6	75
F.4	100	3	1.1	.16	5.5	2	6	1.9	.065	3.5	119

*Milliequivalents/100 grams of oven dry soil.
†Difference between moisture contents at pF values of 3.2 and 4.2.

levant to the fertility status of Missouri soils.

The chemical data indicate a low level of nutrient supply in soils F.5, F.1, and F.4, and responses of legumes to calcium, magnesium, potassium and phosphorus could be expected.

3. *Clover Response*

The results of the fertilizer trials (Series 1) are shown in Table IV.

In the factorial experiment (Series 2) on soil F.7, response to sulphur was shown to be highly significant, while no response was observed for potassium which had been paired with sulphur in the earlier experiment. The possibility of a copper-zinc deficiency as shown in Series 1 was not confirmed in this experiment.

The soils derived from sandstone alone, show response only to phosphorus, despite their low fertility rating based on the chemical and mineralogical data. In particular, the lack of response to calcium, magnesium and potassium in these soils (F.1, F.4) is rather puzzling and may be due in some manner to recent clearing. Deficiencies of these elements would be expected to occur rapidly with increasing time of utilization.

The type of response obtained is related to the source of parent material.

TABLE IV.

Series 1, clover response in yield of dry tops—comparison of significant minus element(s) vs. full fertilizer treatments for five Kyogle soils.

Soil	Group	Parent Material	Oven dry weight of tops in grams/pot			
			Full treatment	Full treatment —K. S	Full treatment —P	Full treatment —Cu, Zn
F.7	Chocolate	Basalt	7.9	6.8†	7.6	7.3‡
F.2	Chocolate	Basalt + sandstone	11.5	7.6*	4.5*	10.2‡
F.5	Amphipodzol	Sandstone + basalt	16.7	12.8‡	10.1*	14.0
F.4	Amphipodzol	Sandstone	9.1	10.6	1.9*	10.2
F.1	Amphipodzol	Sandstone	10.4	9.9	4.3*	10.1

*Significant at $P < .01$.
†Significant at $P < .05$.
‡Significant at $P < .1$.

Thus phosphorus deficiency is related to sandstone derivation. This may be due to a low content of phosphorus in the sandstone and to unavailability of soil phosphorus due to high iron content where lateritised sandstone is exposed at the junction of the sandstone and basalt strata.

Sulphur deficiency, on the other hand, is associated with the basalt parent material. This agrees with the findings of other workers, that soils of basaltic origin are frequently deficient in sulphur for the growth of clover (Hilder, 1954; McLachlan, 1952).

It seems that in the chocolate soils derived purely from basalt, only sulphur deficiency may arise at first, while in the soils derived from both parent materials deficiencies of both sulphur and phosphorus may be expected.

Conclusions

Clearly the use of chemical and mineralogical data *per se* has failed in forecasting the initial fertilizer responses on these soils, although the long-term fertility status is probably indicated with some degree of certainty. Likewise the classification of the soils in terms of great soil groups is not a useful classification of the initial fertilizer responses.

However, recognition of the sources of parent material, with the aid of mineralogical analysis, appears to be helpful in predicting deficiencies of phosphorus and sulphur in this area. Soils which are developed from basalt alone may be expected to respond only to sulphur, soils from sandstone alone to respond to phosphorus, while on soils of mixed origin responses to both phosphorus and sulphur might be expected.

If further work should confirm these expectations, then this approach should help in the rapid assessment of the fertility requirements of the soils in this particular locality where the pedogenesis is understood. To this extent it is an attempt to give pedology a practical rôle in agronomy.

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TECHNICAL NOTES

A PASTURE RESPONSE TO APPLICATIONS OF SODIUM MOLYBDATE

Summary.

Subterranean, Red and White clovers responded to dressings of sodium molybdate applied at the rate of 2 oz. per acre on an acid iron podzolic at Berry.

Introduction

The "Anderson Trial" described in 1952 has been used extensively to eliminate soil mineral deficiencies in the requirements for optimal pasture growth on a range of soil types in the Berry District. Observations seemed to indicate the occurrence of a large number of deficiencies. A replicated factorial experiment was designed to evaluate and confirm the observations.

Method

Because of its frequent occurrence the soil type selected was on an iron podzolic developed in situ from argillaceous sandstone. Surface reaction recorded an average pH of 5.5 (universal indicator). The soil profile and textural classifications were: 0-4", sandy clay loam, pH 6.0; 4"-8", clay loam with sand grains, pH 5.5; 8" plus, clay with occurrence of weathered parent material.

A site was located on Mr. J. Galbraith's property, Berry, which since clearing of its original wet sclerophyll forest community, had received a single application of superphosphate at 1 cwt per acre. Before cultivation the experimental area was vegetated with Summer Grass (*Digitaria sanguinalis* (L.) Scop.), and Japanese Millet; the mature millet being approximately 4 inches in height. A replicated 2^4 factorial, not confounded and split plot to Muriate of Potash at 0, 1 cwt per acre rate was top-dressed including all combinations of:—

Sodium Molybdate ..	0, 2 oz. per acre
Borax	0, 5 lb. „ „
Copper sulphate . ..	0, 7 lb. „ „
Magnesium sulphate	0, 56 lb. „ „

The basal superphosphate level was 5 cwt per acre. The pasture seeds mixture consisting of perennial rye grass, white, red, Tallarook and Mt. Barker clovers was inoculated with *Rhizobium sp.* serological types SU 298, and NA 30, both agar cultures. This mixture was sown together with hydrated lime at 56 lb. per acre.

Result

Green herbage yields were the main estimate of results.

The highest mean response of 31.3 cwt per acre was attributed to the presence of sodium molybdate. In the presence of each of the three other trace elements the molybdate response was greater than in their absence. This was not significant.

The responses to potash in the presence of borax and copper were significant. The interaction between potash and copper was significant.

TABLE I

Mean green yield in cwt per acre.

Potash	Copper	
	Absence	Presence
Absence	102.5	96.5
Presence	96.7	109.5

Discussion

Following independent observations on a large number of type sites for the seasons 1952-3, 1953-4, as well as the con-

firmation of response in a factorial experiment it is reasonable to conclude that a response to applications of sodium molybdate at the rate of 2 oz. per acre may be anticipated on soils developed from shale parent material in the Berry District. Consequently the use of molybdenised fertilizers may be recommended with some degree of confidence.

Further experiments are proceeding using simple pasture mixtures and other improved techniques.

Acknowledgment

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J. STRANG.

Department of Agriculture,
Berry, N.S.W.

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BROWN ROT OF STONE FRUITS

III. INCIDENCE ON THE PHILLIPS CLING PEACH ON LIGHT AND HEAVY SOIL TYPES IN 1955

It seems remarkable that in the extensive literature on brown rot *Sclerotinia fructicola* (Wint.) Rehm., differences in losses sustained by the peach *Prunus persica* Batsch, on contrasting soil types have been unrecorded (Wormald 1954), and that soil as a conditioning factor has been only recently suggested (Angell 1949, 1950, 1951). In peach-growing districts in other countries in which the industry has been long established, it is possible that severe economic loss due to brown rot on some soils was one of the main factors determining the areas to which the crop is now restricted. Plant pathological and soil science laboratories were not established in departments of agriculture until long after the worst areas had been eliminated by trial and error.

Planting on sandy loams and other light soils in the irrigation area around Shepparton, Victoria, has been practised since orcharding began there in 1910. On account of the intrusion of small areas of heavy soil types into selected areas of light soils, plantings are sometimes necessarily on more than one soil type. A few plantings are also found on loams and clay loams.

Dry weather is ordinarily expected in the Shepparton area during the ripening period. Under dry conditions, not more than a few per cent. of brown rot infected fruits generally occurs on any of the soil types but occasional instances of heavy loss have been found on sandy loams. If, however, heavy rains supervene, as they did in 1954 (Angell 1955) differences in losses caused by brown rot on various soil types become obvious throughout the district.

Two weeks before the first deliveries of the variety, Phillips Cling, were made to the cannery in 1955, eight and one-half inches of rain were recorded. The lighter soils were waterlogged. Brown rot soon developed. This was followed in some orchards by shedding of all fruit and foliage of some trees. According to Skene and Freedman (1944) it is unlikely that trees so affected will recover. There was relatively little penetration of water into the heavier loams and clay loams which are comparatively impermeable soils. Most of the water remained on the sur-

face of some of them for as long as two weeks until removed by run-off and evaporation. On such impermeable soils there was less brown rot than on light soils, and shedding of leaves was restricted to a few plants.

Differences within plantings were observed in four orchards. Each planting was on two soil types. On each soil type on each property, the numbers of brown-rotted fruit counted on, or on and under, six trees taken at random, are recorded in Table 1. In two plantings all trees on the light soil and in the other two plantings all trees but one gave a higher count of brown-rotted fruit than any tree on the heavier soil type.

From visual appraisal the total crops borne by the trees on light and heavy soils in orchards 1 and 2 of Table I were equal. Hence the ratio of percentage diseased fruit is estimated by the ratio of the numbers of diseased fruit per tree on the two soil types.

Analysis of the logarithms of the ratios shows that the departure of the mean logarithm from the expected value of zero is significant at the 5 per cent. level, i.e., there is fairly strong evidence from the consistency of the contrasts in these four plantings, that brown rot is more destructive on the lighter than on the heavier soil types. This confirms the findings of the previous season with another variety (Angell 1955).

Since the survey of brown rot in the Shepparton area was started in 1952 with the object of studying environmental factors which influence destructiveness of the disease, there have been three years in which rains sufficiently heavy to cause severe outbreaks have fallen at or immedately before the ripening period. In two of the three seasons the crops of two of four principal varieties grown in the area were seriously affected with brown rot. The loss of a high proportion of five out of sixteen crops (in the present season 750 tons instead of the expected 1,500 tons was received by one cannery) is sufficient to raise serious doubts in the minds of orchardists about the economic future of peach growing and the efficacy of the usual control methods when such weather conditions supervene.

During the past two wet seasons, as many orchards were visited as the limited harvesting period allowed. Only rarely was a light soil found on which the percentage of brown-rotted fruit was not obviously much higher than the percentage in loams. The almost constant association suggested a causal relationship. Other alternatives were not convincing.

TABLE I.

Numbers of brown-rotted fruit on six trees on different soil types in each of four orchards, and relative prevalence of the disease.

Orchard	Light Soil		Heavier Soil		Ratio of percentages	Remarks
	Number of fruits		Number of fruits			
	Brown rotted	Total	Brown rotted	Total		
1	1,612*	—	401*	—	4.04	Shepparton sandy loam vs. Shepparton loam.
2	1,012*	—	299*	—	3.38	East Shepparton sandy loam deep phase vs. Shepparton loam.
3	1,200	1,200	351	2,450	6.98	Drift vs. Lemnos loam.
4	2,550*	3,400	1,550*	3,750	1.81	Broken sand vs. Shepparton sandy loam.

*According to the orchardists, the differences on the contrasting soil types at harvesting a few days later were much greater than is indicated by the figures in this table.

The relatively small number of plantings on heavy soils was not, however, sufficient to override other variables which might have been suggested as contributing factors.

Most of the orchards on loams appear to be producing satisfactory crops. Planting on relatively impermeable soils, or other soils not subject to waterlogging is the most obvious means of avoiding inordinate loss from brown rot.

From the observed sequence, water logging—brown rot—fruit fall—leaf shedding—death of plants, it appears that brown rot is the first of a series of plant reactions to waterlogging at harvest time. If waterlogging is not too prolonged, only the first or the first and second occur. If it occurs during autumn or winter, only the final stage can be manifested. Although drainage appears to be the best means of dealing with waterlogging it is not economically feasible (Skene and Freedman 1944).

Loss by brown rot occurs not only before but after picking. It is suggested that the trends evident on light and heavy soil types before picking continue in storage, and this aspect of the problem should be investigated.

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H. R. ANGELL.

Division of Plant Industry,
C.S.I.R.O.,
Canberra, A.C.T.

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LEAD TOXICITY IN TOBACCO RESEMBLES AN EARLY SYMPTOM OF FRENCHING

A comprehensive spectrochemical analysis was carried out on the above-ground portions of six tobacco plant samples, three healthy and three showing frenching symptoms of varying severity. The relative concentrations of the elements Mg, Zr, Ti, Si, K, Cu, Mn, Mo, Fe, P, Na, Al, Pb, Sn, and Ca in the ashes were determined from this analysis. The plants were grown under comparable conditions on frenching soil from Katherine in the Australian Northern Territory for the frenched plants and on a potting soil used at C.S.I.R.O., Canberra for the healthy plants.

The only elements of those listed showing approximate concentration relationships conforming with the state of health of the plants were Mn, Mo, Al, and Pb (see Table I).

The large differences in values of lead concentration between severely frenched plants and healthy plants suggested lead to be the element worthy of first examination in a program to determine the cause of the disorder. The equality of the concentrations of lead in the plant ashes referred to in the last two columns of the table was considered of little importance since the frenched plant showed only

TABLE I.

Relative concentrations of Mn, Mo, and Al, and concentrations in parts per million of Pb in ashes of frenched and healthy tobacco plants.

Element	Old Plant Frenched	Old Plant Healthy	Seedlings Severely Frenched	Seedlings Healthy	Young Plant Slightly Frenched	Young Plant Healthy
Mn	5.5	5.0	9.5	3.0	10	3.5
Mo	7.5	6.0	10	5.5	6.0	4.5
Al	7.0	3.5	9.0	3.0	5.5	10
Pb	400	70	350	55	150	150

slight symptoms which could well have been induced by some other factor influencing the disorder.

Spectrochemical analysis of the soils on which the plants referred to in Table I were grown showed that both the type causing frenching and that giving healthy plants contained about 50 p.p.m. Pb. This suggests that, if lead is the cause of frenching, another factor affecting its availability must be operative.

Consideration of the conditions favouring the occurrence of frenching and physico-chemical factors which would influence the availability of lead in soils also favoured the choice of lead for investigation. The following were the points considered:

Since it is probable that lead occurs in soils as the carbonate or basic carbonate, which are less soluble than other lead salts which may exist in an oxidising soil environment (Ramkama and Sahama, 1949), it would become available to plants at high pH (about 8) through the formation of the moderately soluble bicarbonate (International Critical Tables 1930) and its availability would be enhanced by waterlogging which would cause increase in the partial pressure of CO_2 in the soil atmosphere. Both high soil alkalinity (Karraker and Valleau, 1930) and persistent or heavy rain (Garner, 1951) have been found to favour the incidence of frenching.

Lead is an element of widespread occurrence in soils (Mitchell, 1948) (Butler, 1954), the examination of some 50 spectrograms of Australian soils showing over half of them to contain lead in excess of 50 p.p.m. Hence, lead toxicity could well be an alternative to microbiological activity (Shear and Ussery, 1940) in explaining the geographically widespread incidence of frenching.

Quite severe frenching was found to occur in plants grown in sand from the Molonglo River collected at a point about 30 miles downstream from mineral deposits containing galena and cerussite in workable quantities. A trace of lead was found by qualitative spectrochemical analysis of this sand. An attempt at extracting the lead from this sand using a saturated solution of CO_2 was only successful in that it increased the time from planting to the first incidence of frenching symptoms from 16 to 21 days which suggested that, if lead were the cause of frenching in tobacco grown on this sand, its extraction from the sand was incomplete under the conditions used.

Next, a series of lead treatments in glass-making sand (sterilised at 150°C. for 1 hour) watered to saturation with one-tenth strength nutrient solution and kept at 35°C. in the greenhouse was set up. The lead levels (each in quadruplicate) were 0, 2, 6, 18 and 54 p.p.m. Pb as lead carbonate mixed throughout the sand which was contained in 300 ml.

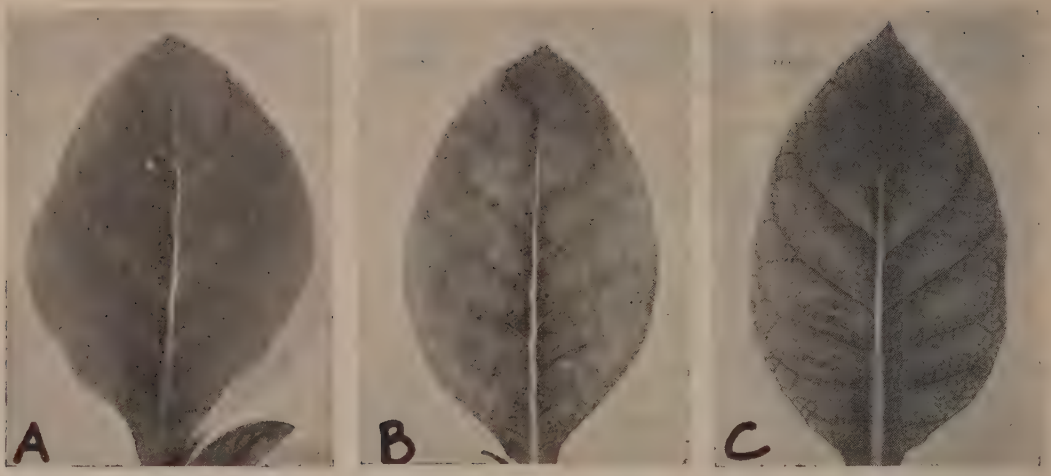

Figure 1.

(a) Healthy leaf of a control plant of tobacco (no lead treatment).

(b) 54 p.p.m. lead treatment

(c) Leaf from a plant growing in frenching soil showing initial symptoms of frenching.

Pyrex beakers. Three of the 54 p.p.m. replicates showed reticular chlorosis of the small leaves, similar to that encountered in the early stages of frenching, in 26 days from planting. The fourth replicate showed these symptoms 3 days later and each replicate showed reticular chlorosis in three successive leaves as they emerged from the stem apex. None of the other levels caused reticular chlorosis and there was no evidence of strapped leaves. Increasing lead concentration caused decreasing size of the plants.

Figure 1 shows a healthy leaf of a control plant (no lead treatment), a leaf of a 54 p.p.m. Pb treatment and a leaf showing the initial symptoms of frenching from a plant grown on a frenching soil.

In an experiment conducted under the same conditions but using 0, 40, 160 and 640 p.p.m. Pb levels, reticular chlorosis occurred in all replicates of the 40 p.p.m. treatment and severe stunting occurred at the higher levels. Plants of the 160 p.p.m. treatment developed necrotic patches on the leaves and necrosis of the stem apex became apparent in the 640 p.p.m. treatment after 50 days from planting.

Similar symptoms were induced by placing a tobacco plant for 2-day periods alternately in nutrient solution and a 1:40,000 solution of lead acetate or by applying a 1:1,000 lead acetate solution to the leaves either by painting with an abrasive or by injection using the "wick and glass tube" method. These treatments induced reticular chlorosis in four to five weeks.

On the basis of the evidence presented in this note it is suggested that lead may be a contributory factor in frenching of tobacco. Lead is of widespread occurrence in soils and conditions known to favour frenching are those favouring an increase in the solubility of lead. Moreover, treatments which reduce frenching, e.g., heat sterilization and aeration, are those which will lessen the availability of lead.

The investigations are being continued.

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D. J. DAVID.
D. C. WARK.
M. MANDRYK.

C.S.I.R.O.,
Canberra, A.C.T.

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NOTES ON THE PHOSPHATE STATUS OF SYDNEY SOILS

Work by Storrier (1951), Beadle (1952) and Moraghan (1953) has shown that Sydney soils have low levels of phosphorus. Subsequent to a detailed reconnaissance soil survey of the County of Cumberland, Sydney Region, by Walker (1954), a pot trail was designed to observe the effect of superphosphate additions at various rates on a number of important soil types.

Method

Surface horizons were sampled for each type and the superphosphate treatments were equivalent to control, ½, 1 and 2 cwts per acre. Inoculated Mount Barker strain subterranean clover was used as the indicator plant. After 8 weeks, all the plant material, including roots, was harvested from each pot (small glass beakers were used), oven dried at 105°C. and weighed.

Results and Discussion

There was a positive growth response, as measured by yield, to the application of superphosphate in all soils. A response in the case of Moorebank, Yarramundi, and Hammondville series was not obtained until added superphosphate reached the level of 2 cwt per acre. In the Prospect series maximum response was evident with the 1 cwt. per acre application.

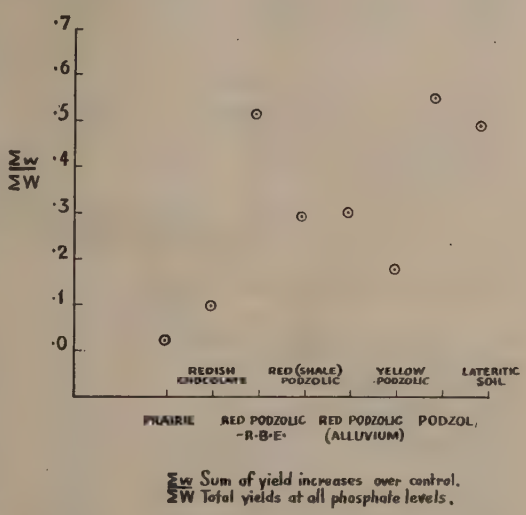

Figure 1.
Relationship of weathering and response to superphosphate.

For the purpose of discussion the soils may be arranged in a weathering scale based on the degree of expression of podzol morphology (see Figure 1). The range is from an immature prairie soil (Moorebank) and reddish chocolate soil (Prospect) through red podzolic-red brown earth transition (Lansdowne), red podzolic (Cumberland, Yarramundi) and yellow podzolic (Hammondville) to a podzol (Hawkesbury) and a lateritic residual soil (Wahroonga).

The scatter of points (Figure 1) indicates a general relationship which may be summarised as—"Increased podzolisation means increased response to phosphate".

Table I shows the relationship between yield and increasing phosphate application. The yield of plant material from the untreated pots follows the expected natural fertility of the soils based on the "relative richness" of their parent materials.

Together with the siliceous shales, the coarse-grained sandstone shows the poorest plant growth; while the calcareous shales, dolerite, and alluvial soils show much greater nutrient resources. This table is to be interpreted more as a general nutritive picture rather than in terms of one particular element.

Nodulation

In most cases the degree of nodulation of plants in the virgin soils was very poor. However, after 1 cwt of superphosphate had been added, maximum development of nodules was reached, and only in the soils of sandy texture was there evidence of a further nodulation increase, beyond 1 cwt of superphosphate.

Soils with less than 6 m-equiv. exchangeable calcium, e.g., shale, sandstone and alluvial soils, showed no nodulation in the control, but nodulation appeared and increased with added phosphate. In soils of up to 17 m-equiv. calcium, e.g., Prospect and Lansdowne series, nodulation was suppressed and was found to be reduced at high superphosphate rates.

Conclusion

Most soils of the County of Cumberland were found to be deficient in phosphate when Mount Barker strain of subterranean clover was used as an indicator plant.

TABLE I.

Relationship between yield and increasing phosphate application for various soil types.

Soil type	Parent material	Great soil group	Yield (grams) response to various rates of phosphate			
			0	¼	1	2 cwts
Hawkesbury sand	Hawkesbury sandstone	Litho-Podzol	0.096	0.200	0.236	0.312
Cumberland clay loam	Wianamatta clay shale	Red Podzolic	0.103	0.218	0.318	0.232
Wahroonga clay loam	Mottled horizon of laterite on shale	Red Lateritic	0.115	0.167	0.307	0.329
Hammondville fine sandy loam	Sandy shale (passage beds)	Yellow Podzolic	0.169	0.127	0.179	0.302
Lansdowne clay loam	Ostracod sandstone (Wianamatta)	Red Podzolic	0.170	0.422	0.415	0.416
Yarramundi sandy loam	Alluvium (Pleistocene)	Red Podzolic	0.267	0.316	0.333	0.455
Prospect clay loam	Dolerite	Reddish Chocolate	0.291	0.337	0.358	0.305
Moorebank fine sandy loam	Alluvium (Recent)	Immature Prairie soil	0.357	0.351	0.322	0.425

Added phosphate was required to bring plant growth to a maximum and further growth increases could be expected above 2 cwt. superphosphate per acre.

There is evidence that the available phosphate status in virgin soils depends largely on the parent material, and that with increase in weathering and leaching in the process of soil formation, the amount of available phosphate shows a corresponding decrease.

In almost all the soils, clover nodulation increased with increased soil phosphate. Generally there was a close relationship between degree of nodulation and plant response; this indicates a relationship between phosphate and nitrogen in the nutrition of clover plants.

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R. R. STORRIER.
P. H. WALKER.

Department of Agriculture,
Sydney, N.S.W.

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AN OUTBREAK OF RUGOSE LEAF CURL DISEASE ON CLOVER IN QUEENSLAND

A disease causing high mortality in red clover (*Trifolium pratense* L.) at Gatton, Queensland, has been identified as that caused by Rugose Leaf Curl virus. Rugose Leaf Curl virus was shown to be transmissible to a number of species of plants, including legumes, by the leafhopper *Austroagallia torrida* Evans (Grylls, 1954). The virus was first discovered when field-infected *A. torrida* were fed on susceptible plants in the laboratory. No symptoms of the virus have yet been observed in the field in the A.C.T. where the first infected leafhoppers were found. *A. torrida* is known to be widely distributed in all of the mainland States except Victoria and it probably occurs there also.

Diseased white and red clover plants found at the C.S.I.R.O. Field Station at Strathpine, Queensland, in 1954, were infected with Rugose Leaf Curl. The identification was confirmed by transmitting the disease to *Malva parviflora* L. by virus-free leafhoppers fed on one of the infected plants.

The report of the outbreak at Gatton was received early in April, 1955. The disease occurred in a mixed pasture on the property of the Queensland Agricultural High School and College, and in a red clover—Phalaris pasture on the irrigation farm of the Queensland Department of Agriculture and Stock. This is the first record of a major field outbreak of the disease.

Between 10 per cent. and 12 per cent. of red clover plants and some white clover plants were infected in the College pasture. On the irrigation farm the attack was more severe, it being apparent that many plants in plots planted in May, 1954, had already succumbed to the disease. Four one chain traverses were made over one of the plots that had been grazed. Of a total of 140 plants under the tape 70 were definitely infected and 22 were doubtfully infected. As some

plants were already dead it is evident that the effect of the disease may be devastating. Adjacent white clover plots had a small percentage of infected plants and this species may be more resistant to the disease. Small numbers of *A. torrida* were present on both white and red clover plots when the investigation was made.

Attempts have been made previously to grow red clover in the Lockyer Valley, Queensland, but the crop has rarely survived more than 2 years. It is possible that Rugose Leaf Curl virus may be an important factor restricting the establishment of red clover in some areas.

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N. E. GRYLLS.

Division of Entomology,
C.S.I.R.O.,
Canberra, A.C.T.

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BOOK REVIEWS

VEGETABLE PRODUCTION AND MARKETING

By PAUL WORK and JOHN CAREW

(N.Y., John Wiley; London, Chapman and Hall, 1955, $4.72).

This book, intended for teachers and students, provides a comprehensive study of the intensive and exacting agricultural operations and problems of vegetable culture. Although written primarily for use in the United States the book is applicable to Australian conditions in most particulars.

The technical information is up-to-date and includes all the important results of research in the last decade. This is valuable to the research worker directly associated with vegetable crops and also to others who find it necessary to grow vegetable crops in their research programme.

The tables are most useful, moreover the text is well illustrated and there is a long list of references at the conclusion of each chapter. There is also an excellent chapter on the home garden and the vegetable hobbyist will find this book interesting and instructive.

R. O. KEFFORD.

A HERITABLE VARIATION IN TOBACCO OF PALATABILITY TO LOOPER CATERPILLARS

The larva of *Plusia argentifera* Gn. (known locally as the looper caterpillar) caused severe damage to tobacco in North Queensland until new insecticides were introduced in 1953-54. During the 1952-53 and 1953-54 seasons some varieties were observed to be unpalatable to the caterpillars in the field. Moths laid eggs on these varieties; but first instar caterpillars migrated before appreciably damaging the leaves. Figure 1 shows the relative damage to Maryland Mammoth (unpalatable) and Oxford 26 (palatable) in adjacent rows. The differences in palatability did not appear to be associated with differences in the alkaloid or carbohydrate content of the leaf. They may have been associated with surface differences such as differences in the number of leaf hairs per unit area.

A method of quantitatively testing palatability was devised for use in conjunction with field observation. Test leaves were taken from the top third of each plant. Leaves from a number of varieties were evenly spaced along a rigid wire and hung for 60 hours in a box containing approximately 4 large caterpillars per leaf. The caterpillars were able to reach the leaves from the sides and bottom of the box. The outline of each leaf was traced on paper before placing the leaf in the box. The final outline was again traced on the same sheet of paper after the caterpillars had eaten part of the leaf. These outlines were subsequently cut out and weighed. The initial area was corrected for shrinkage, as determined in control leaves exposed to similar conditions (but without caterpillars). The proportion of the area eaten by the caterpillars was estimated by the weight difference.

In the 1953-54 season a number of varieties and the F_1 hybrids of Maryland Mammoth were tested by the box method. F_1 hybrids of the other unpalatable varieties were tested in 1954-55. The relative damages of varieties and F_1 hybrids are shown in Table I.

In general, the F_1 hybrids were closer in palatability to the palatable parent than they were to the unpalatable parent.

In the 1954-55 season individual leaves of 153 F_2 plants and 40 leaves of each parent of the cross Maryland Mammoth x Virginia Gold were tested by the box method. More than one leaf from each plant could not be tested because insufficient caterpillars were available. However, three leaves of each of eight plants from the segregating hybrid population were tested three days later, giving a correlation of .94 between leaves from the same plant. This agreement between leaves from the same plant was closer than expected, as in the field the lower leaves are more severely damaged than the upper leaves. The distributions of the amounts of damage in the parents and the F_2 hybrid are shown in Table II. The segregation in the F_2 generation did not give ratios which would suggest that a small number of genes controlled the inheritance of palatability. Figure 2 shows the extent of the differences observed between test leaves.

TABLE I.

Percentage damage by the larva of Plusia argentifera Gn. of tobacco varieties and F_1 hybrids.

Variety or hybrid	Type	Percentage damage (mean of 5 leaves)	Mean square root transformation
1953-54 season			
One Sucker	Snuff	<.5	—
Bottom Special	Flue-cured	1.3	1.0
Maryland Mammoth	Air-cured, short day	2.0	1.4
Samsun	Turkish	2.2	1.5
Vamoor 50	Flue-cured	8.2	2.9
Manilla	Air-cured	8.3	2.9
M.R.S. 202	Air-cured	9.5	3.1
Yellow Special A	Flue-cured	10.1	3.2
Hicks	Flue-cured	10.3	3.2
401	Flue-cured	12.6	3.5
M.R.S. 90	Air-cured	15.3	3.9
Virginia Bright Leaf	Flue-cured	16.2	4.1
Dixie Bright 102	Flue-cured	18.5	4.3
400	Flue-cured	20.9	4.6
402	Flue-cured	22.4	4.7
Vesta 33	Flue-cured	27.6	5.2
Vesta 30	Flue-cured	28.3	5.3
Dixie Bright 101	Flue-cured	38.0	6.2
Xanthia	Turkish	38.4	6.2
Virginia Gold	Flue-cured	39.4	6.3
Cash	Flue-cured	43.6	6.6
Smyrna	Turkish	47.4	6.8
Ambalema	Mosaic Resistant	64.0	8.0
F_1 Maryland Mammoth x Yellow Special A		11.8	3.4
F_1 Maryland Mammoth x Virginia Gold		27.0	5.2
Sig. diff. $p = 0.05$			0.4
$p = 0.01$			0.5
$p = 0.001$			0.6

TABLE I (*Continued*).

Variety or hybrid	Type	Percentage damage (mean of 5 leaves)	Mean square root transformation
1954-55 season			
Maryland Mammoth	Air-cured, short day	3.1	1.7
Spanish Mosaic-Resistant	Ambalema factor	15.5	3.9
402	Flue-cured	35.9	5.9
Oxford 26	Flue-cured	48.4	6.9
Virginia Gold	Flue-cured	54.6	7.4
F_1 Vamoor 50 x One Sucker		31.8	5.6
F_1 Vamoor 50 x Bottom Special		22.8	4.8
F_1 Vamoor 50 x Samsun		19.2	4.4
F_1 Yellow Special A x One Sucker		16.1	4.0
F_1 Yellow Special A x Bottom Special		26.4	5.1
F_1 Yellow Special A x Samsun		12.2	3.5
F_1 Dixie Bright 101 x One Sucker		27.2	5.2
F_1 Dixie Bright 101 x Bottom Special		37.0	6.1
F_1 Samsun x Dixie Bright 101		40.3	6.3
F_1 Virginia Gold x One Sucker		46.4	6.8
F_1 Virginia Gold x Bottom Special		53.2	7.3
F_1 Virginia Gold x Samsun		62.8	9.9
Sig. diff. $p = 0.05$			0.5
$p = 0.01$			0.6
$p = 0.001$			0.8

These data indicate that—

(1) Tobacco varieties differ in their palatability to looper caterpillars;

(2) Unpalatability is recessive in the F_1 generation of all the crosses tested;

(3) Transgressive segregation in the F_2 generation, with extreme variability, suggests that many genes are involved in determining the relative palatability of a plant.

TABLE II.

Percentages of plants of Maryland Mammoth, Virginia Gold and their F_2 hybrids grouped according to damage of sample leaves by looper caterpillars.

Damage of sample leaves by looper caterpillars	Percentage of plants in each grouping		
	Maryland Mammoth (40 plants)	F_2 hybrid (153 plants)	Virginia Gold (40 plants)
0-10	97.5	32.3	
10.1-20	2.5	19.7	
20.1-30		5.2	
30.1-40		9.8	
40.1-50		7.2	
50.1-60		11.8	20.0
60.1-70		5.2	80.0
70.1-80		4.6	
80.1-100		3.9	
	100.0	99.7	100.0

Figure 1.
Leaf damage by looper caterpillars in the field. Maryland Mammoth (left). Oxford 26 (right).

Figure 2.
The range of damage by looper caterpillars to test leaves in F_2 generation of Virginia Gold x Maryland Mammoth.

D. C. WARK.

Division of Plant Industry,
C.S.I.R.O.,
Canberra, A.C.T.

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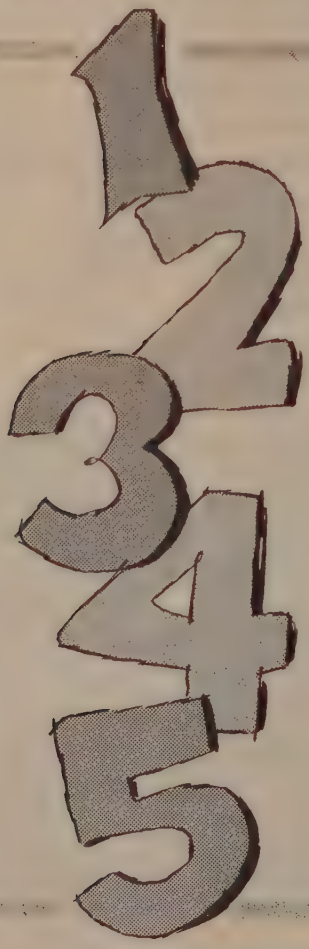

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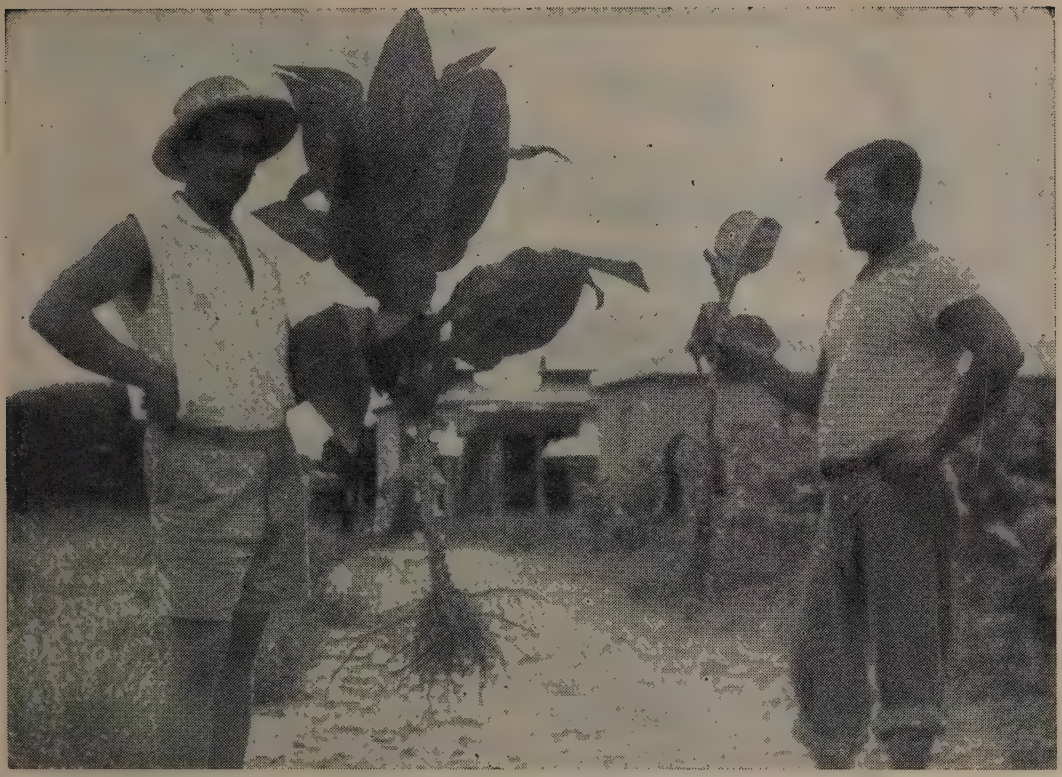

Tobacco plant grown in fumigated soil compared with plant from untreated ground.

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NEWS ITEMS

Australian Wine Research Institute.

During May 1955 a Bill was passed in Federal Parliament to establish a Wine Research Institute. The Bill provides for the establishment of a Trust fund of £500,000 for the purposes of encouraging research into oenology and viticulture.

The money originated from the Wine Export Encouragement Trust Account established in 1930 to which money was paid from part of the excise on fortifying spirit. This was used for paying wine bounty on export wines. As wine export declined during the war this Trust Account increased to over a million pounds in 1946. After a Tariff Board enquiry, the Government in 1947 ceased paying wine bounty and set up the Wine Industry Assistance Account with £500,000 under the Wine Export Bounty Act 1947. This last Act was repealed in 1955 and the money was made over to the Wine Research Institute Trust Fund.

The Wine Research Institute was registered under the Companies Act of South Australia to enable the Trust fund to be created.

The Trust fund is to be administered by a Wine Research Institute Council and the following members have been appointed :

Mr. M. Auld (Chairman), Mr. K. T. Hardy, Mr. I. M. Seppelt, Mr. H. R. Haselgrove, Dr. H. C. Forster (C.S.I.R.O.), Mr. J. Lyons (Dept. of Customs), Prof. J. A. Prescott and Mr. C. P. Haselgrove.

The Council have advertised the position of Director of Research.

Fruit Fly and the Export of Oranges.

The weather last summer in eastern Australia was very favourable for the development and spread of the Queensland fruit fly which has spread alarmingly in recent years. During late summer a major outbreak of this serious orchard pest occurred on the Murrumbidgee Irrigation area and flies were active on a number of fruit farms. Fruit fly was also found in the mid-Murray citrus growing area near Barham. These outbreaks had serious consequences for the citrus industry.

Both these areas normally export considerable quantities of oranges to New Zealand. The quarantine regulations in New Zealand, where fruit flies do not occur, prohibited the importation of fresh fruit from anv orchard within a radius of 50 miles of an affected area, unless the fruit has been cool stored for 21 continuous days at a temperature of 31°F. The New Zealand authorities accordingly prohibited the importation of citrus fruits from the M.I.A. and the mid-Murray areas until December 1955, unless subjected to the above treatment. The position will then be reviewed. It is unlikely that much fruit could be held at 31°F. for three weeks without suffering low temperature injury.

Following a joint submission from New South Wales and Victoria, in which it was pointed out that the New Zealand market for a quarter of a million cases of oranges was in jeopardy and that prices in Australia would be adversely affected, the matter was discussed by the Standing Committee on Agriculture and the Agricultural Council. These bodies considered that, in view of the latest developments, the fruit fly menace should be regarded as a national problem which necessitated a campaign involving special and co-ordinated Commonwealth and State activities.

A programme of experimental work is being undertaken with highest priority being given to investigations aimed at discovering techniques which will permit the re-opening of the citrus export trade from those areas which have had to cease this trade because of the spread of fruit fly.

Earlier work by the C.S.I.R.O., Division of Food Preservation and the N.S.W. Department of Agriculture has indicated that both the cold storage treatment (14 days at a temperature of 31°F. may be enough) and fumigation with ethylene dibromide may, under certain conditions, kill all stages of Queensland fruit fly in oranges without damaging the fruit. The question of fruit injury is important, as at times, both treatments may adversely affect the fruit and this aspect is receiving considerable attention. It is expected that, by the beginning of the next citrus season in May, a sterilization treatment satisfactory to both the exporters and the New Zealand authorities will be available to the industry.

Nuffield Scholarship.

The Nuffield Foundation will award travelling scholarships this year to two farmers selected from New South Wales, the Australian Capital Territory and Queensland. The scholarships will enable the farmers to study farming practices and conditions of agricultural life in Great Britain. The scholarships are tenable for six months and the successful applicants, who will be preferably between 25 and 35 years of age, will be placed with progressive practical farmers whose interests correspond with those of the scholar and who have a good general knowledge of agriculture in the United Kingdom.

Hybrid Maize.

This year Government certified hybrid maize seed, of several varieties suitable for various districts, is available to growers in New South Wales for the first time. Similarly it is the first time that no open-pollinated varieties are recommended by the N.S.W. Department of Agriculture. It has been clearly shown in trials at Hawkesbury Agricultural College that second generation seed should not be used as the yield is 20-25 per cent. less than from certified first generation seed.

In the 1953-54 season 55 per cent. of the maize acreage in N.S.W. was sown to hybrid maize which yielded on the average 43 per cent. more than the open-pollinated varieties.

Enrolments in Course of Agricultural Science at Australian Universities.

The numbers of students enrolled in each year of the degree course in Agricultural Science at the six Australian Universities in which a course is conducted are summarised in the following table which covers the period 1951 to 1955. The information has been supplied by the Registrars of the Universities.

At the University of Tasmania, the first year only of the course may be undertaken. Students who pass that year, generally continue their course at the University of Melbourne.

	Year of Course	Numbers Enrolled				
		1951	1952	1953	1954	1955
Adelaide	1	12	19	14	15	29
	2	5	6	8	13	8
	3	7	4	3	5	11
	4	7	6	2	2	4
	Honours	2	1	3	2	1
Melbourne	1	24	37	48	61	51
	2	24	16	18	26	33
	3	30	36	21	26	37
	4	28	16	27	18	17
Queensland	1	13	13	10	17	21
	2	13	9	9	7	16
	3	12	8	5	9	4
	4	12	12	9	5	9
	Honours	1	3	1	3	—
Sydney	1	35	33	32	54	73
	2	29	27	20	26	38
	3	32	25	29	21	24
	4	29	29	24	27	18
	5	11	8	8	3	6
Tasmania	1	3	5	2	5	6
West Aust.	1	20	19	24	13	15
	2	10	15	12	14	6
	3	18	11	16	10	14
	4	23	16	8	15	9
	Honours	3	6	2	2	5
Totals—All Universities	1	107	126	130	165	195
	2	81	73	67	86	101
	3	99	84	74	71	90
	4	99	79	70	67	57
	5	17	18	14	10	12

Note on First Year Enrolments:

If it is desired to compare the proportion of students who complete first year and continue to second year in the various Universities, it should be noted that the numbers quoted for first year are subject to some variation. The numbers quoted are those enrolled at the beginning of the year, but the numbers who enrol for examinations at the end of that year are generally more at Melbourne, and slightly less at Queensland. At Adelaide, Sydney and Western Australia very little change is experienced.

Australian Journal of Agricultural Research.

Concession Rates to Institute Members.

Towards the end of 1949 the Institute arranged with C.S.I.R.O. to take a bulk supply of the Australian Journal of Agricultural Research for distribution to its members. The Journal was made available to members of the Institute for 15/- per annum as against 30/- per annum to other subscribers. The venture was initiated solely to provide members with what was thought might be a useful service. The Institute makes no profit from the distribution of the Journal.

At the beginning, some 160 members availed themselves of this concesson, but at present only 15 members are receiving the Journal through the Institute. Members are reminded that the Australian Journal of Agricultural Research is available to them at a concession rate. If it is desired to subscribe to the Journal, 15/- should be remitted to the Executive Officer, at the Central Office. 226 Clarendon Stret, East Melbourne, C.2, Victoria.

Institute Membership, 1939-1954

The accompanying graphs illustrate the corporate membership of the Australian Institute of Agricultural Science over the period 31st December, 1939 to 31st December, 1954.

The histograms (Figure 1) show the total corporate membership at the end of each five year period. The total membership of the Institute was 331 at 31st December, 1936, a year following its establishment. The increase in membership was steady until 1950 when substantial gains were made, and a total of 1,105 corporate members was achieved by 31st December, 1954.

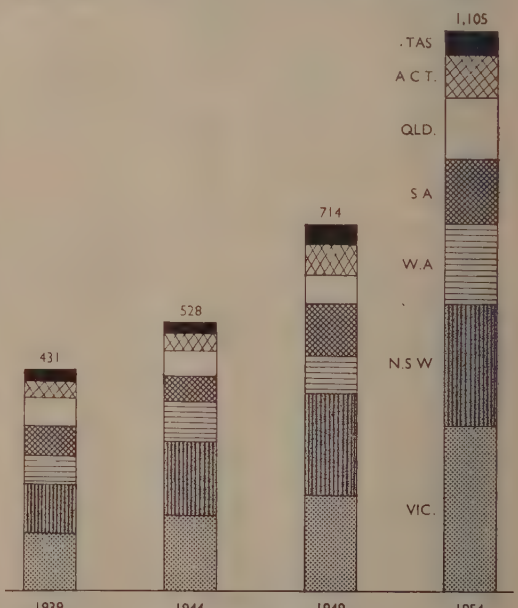


Figure 1.
Institute Membership at five year intervals.

The membership standing of each Branch in each year from 1949 to 1954 is shown in the graph (Figure 2). This demonstrates that the considerable increases in membership by 1954 were due to the cumulative effects of rises in Victoria, Western Australia and Queensland.

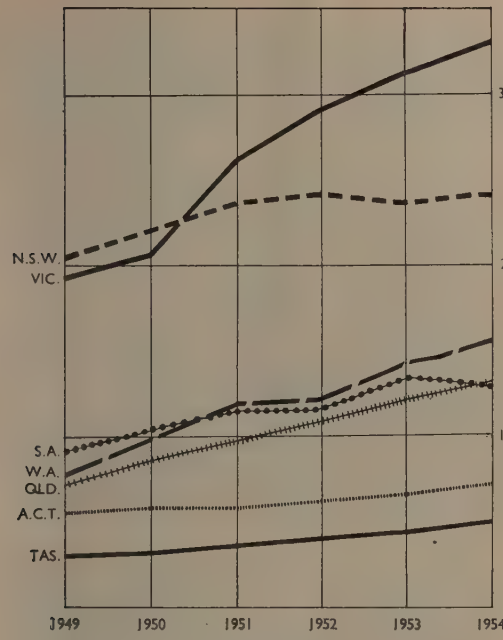


Figure 2.
Trends of Branch Membership, 1949-54.

Future rises in membership will be influenced by the Institute's campaign to increase the numbers of students undertaking courses in agricultural science in Australian Universities. The results of this campaign, which commenced in 1953, are shown in detail elsewhere in this issue of the Journal. First year enrolments in 1955 were 50% more than in 1953.

Potash—Its Use in Australian Agriculture.

In recent years there has been a notable increase in the use of potash fertilisers in Australia, particularly in the period since 1952. Annual returns of potash usage, which are now compiled by Potash (Australasia) Pty. Ltd., show that during 1954 consumption increased in all States and on practically every type of crop.

The following table shows the rate of increase since 1950 :—

Potash usage in tons K_2O.

Year	Source	
	Dept. Commerce & Agriculture	*Potash (Aust.) Ltd.*
1950	7,692	—
1951	6,457	—
1952	9,496	9,592
1953	—	11,886
1954	—	13,866

There has been a rapid increase in potash usage on pastures in both Victoria and Tasmania, and on tropical fruits in Queensland. Less spectacular, but nevertheless substantial increases have occurred on fruit in all states, market gardens in New South Wales, Victoria and Western Australia and potatoes in the same three states and Tasmania.

Muriate of potash forms about 90% of the total amount used, and the sulphate accounts for the remainder.

International Seeds Testing Association.

Miss A. Myers, Seeds Officer of the N.S.W. Department of Agriculture has been appointed a member of the Rules Committee of the International Seeds Testing Association.

Miss Myers was nominated for the position by Australian seed testing officers at a conference held in Melbourne last year. Alterations to existing rules will be discussed at a conference of the Association in Paris next year and suggestions from Australia are being prepared by Miss Myers.

Record Yields.

It has been reported that a 6½ acre crop of hybrid Golden Cross Bantam Sweet Corn on the property of Mr. W. J. Atkinson at Tumut, N.S.W. yielded 9 tons per acre last season. Mr. L. R. Kavanagh, maize specialist of the N.S.W. Department of Agriculture believes this to be a record for New South Wales and probably for Australia.

A record yield for grain sorghum grown in New South Wales was established on Mr. N. Huntley's property in the Werris Creek district. An 89-acre crop of the Caprock variety gave an average yield of 120 bushels per acre. It was grown after a crop of wheat and without additional fertilizer.

A 60-acre rice crop at Yenda on the Murrumbidgee Irrigation Area has yielded four tons per acre—a world record for machine-harvested rice. During the last season weather had been ideal for maximum yields. Subterranean clover is now extensively used in the pasture phase in the rice rotation and more than 90 per cent. of rice growers on the M.I.A. now use certified Caloro seed. The District Agronomist of the N.S.W. Department of Agriculture at Griffith attributed the record average yield of 2.5 tons per acre for the whole of the M.I.A. to these three factors.

Pea Processors' Conference.

A Pea Processors' Conference was held under the auspices of the Victorian Chamber of Manufactures in Melbourne on July 27 and 28. The Conference was attended by more than 50 delegates from all States except Queensland and Western Australia. Commercial canning, quick-freezing, and dehydration interests were represented by top executives and laboratory and field staffs, and officers from the various State Departments and from C.S.I.R.O. were present.

The Conference was opened by Dr. S. T. Bastow (C.S.I.R.O.) after which a series of eight addresses on problems agricultural and technological were presented. At the concluding session a Committee was formed to organize the next annual meeting of the "Australian Vegetable Processors' Convention."

One of the big problems is the Australian production of pea seed for the processing industry. At present all the seed comes from New Zealand.

Careers Exhibition in Sydney.

As a further endeavour in the recruitment campaign for agricultural scientists, the N.S.W. Branch organized an exhibit covering "Careers in Agricultural Science" during the recent "Careers Exhibition" held in the Sydney Trocadero, 29th August-1st September, 1955.

The exhibition was sponsored by a wide range of organizations, including public service, professional institutes and industry. Each exhibit was organized to demonstrate the nature of employment available in various vocations. In particular, aspects related to qualifications and the nature and type of training were depicted.

The arrangement of the exhibit "Careers in Agricultural Science" by the N.S.W. Branch was made possible by a grant received by the Commonwealth Department of Commerce and Agriculture and the generous help received from the Under Secretary and officers of the Department of Agriculture and the Professor and members of the staff of the Faculty of Agriculture. The N.S.W. Branch gratefully records appreciation of these organizations and wishes to thank all members who assisted for their willing co-operation.

The exhibit depicted as its centre theme, shown by moving colour slides, the activities of a student in agricultural science. This was closely connected with exhibits indicating the courses available at Sydney University and the University of Technology. The wide and varied nature of the course work was depicted stressing the value of basic studies of the Plant, the Animal and the Soil and other integrated studies in the training of an Agricultural Scientist.

In order to attract the attention of interested school children the careers open to the graduate were conveniently divided in "Work in the Laboratory," "Opportunities in the Field." Suitable working models, supported by colour transparencies and photographs gave a good coverage of the professional opportunities in agriculture.

Arrangements were made to print a brochure giving further details. This hand out was attractively prepared and was widely distributed during the exhibition.

Open Day at the University of Sydney.

During the recent Open Day at the University, 23rd July, considerable public interest was created by the Faculty of Agriculture.

Course work was well illustrated, and many aspects of the Research programme were demonstrated. Lecturettes were given by Faculty members and appropriate films shown.

The fact that over 3,000 visitors passed through the School is sufficient indication of the value of the Faculty display in outlining the features of a University course in Agricultural Science.

The members of the Institute further appreciated the efforts of the Faculty in presenting a brochure outlining career opportunities in agriculture.

Special Study of Tobacco Problems in Queensland.

A special section which will concentrate on tobacco production is being organised within the Queensland Department of Agriculture and Stock. The tobacco section will handle research into field problems and, at the same time, provide an extension service for growers. The growth of the tobacco industry has been one of the outstanding agricultural developments in recent years. Its expansion into an industry worth £2,500,000 a year to the State has proceeded at the rate of £500,000 a year for the last five years. With 4,000 acres under a crop yielding approximately 6,000,000 lbs. of leaf, the Queensland tobacco industry provides two-thirds of the total Australian production.

The State is showing its faith in the future of the industry by increasing the irrigation facilities to growers. New weirs have been built and two major irrigation projects are being developed in the Barron and Burdekin rivers. With the development of irrigation and the expansion in the acreage under tobacco, special attention by technical officers is required. In the past much important research work has been carried out on the control of pests and diseases, soil problems, varieties and fertiliser requirements.

Three tobacco experiment stations are being developed at Parada (near Mareeba), Millaroo (Lower Burdekin), and Inglewood. A shortage of technical staff has handicapped the full development of these stations, but investigations have now been commenced at Inglewood, and progress is being made in the erection of buildings and clearing at Parada and Millaroo.

Viticulture Research in W.A.

The W.A. Dept. of Agriculture has established a viticultural research station in the Upper Swan district at which work on vineyard management and cultural problems will be carried out. An advisory committee has been appointed and is composed of the Superintendent of Horticulture, as Chairman, the Government Viticulturist, the Chief Plant Nutrition and Research Officer, the chairman of the Vine Fruits Research Trust, two grower representatives of the Viticulturalists Union, one grower representative of the Export Grape Growers Association and a representative of the Packers Association.

Safflower.

Last season a trial crop of safflower grown on the Department of Agriculture's experiment station at Tamworth, N.S.W., returned approximately £55 per acre as against £35 per acre for linseed in the same trials and £20 per acre for wheat. The varieties tested were developed by the C.S.I.R.O.

It is considered that safflower could have value as a commercial crop in N.W. New South Wales. The crop needs more summer rainfall than wheat and it is not likely to be economic in other areas. A very satisfactory drying oil for use in paints is obtained from the seed and the residue makes a valuable protein meal for stock. The crop can be grown and harvested with machinery used for wheat.

Food and Agriculture Organisation of the United Nations.

An F.A.O. meeting on *Livestock Production under Tropical Conditions* was held in Brisbane from the 22nd to 26th August at the University of Queensland, St. Lucia. The objects of the meeting were:

(a) to review the current status of livestock production in the tropical areas under the administration of the countries represented;

(b) to examine: (i) representative current research and developmental projects concerning livestock production in those areas, and (ii) recently developed techniques applicable to research and development in livestock production in tropical conditions;

(c) to formulate general views regarding the future planning and conducting of research and developmental projects in tropical countries;

(d) to arrange for the exchange of information between countries on the progress of such recently developed techniques and the results of current and future research work.

Grasshoppers.

Extensive hatchings of grasshoppers are expected to occur in the south-west of New South Wales this spring. A recent survey by officers of the Department of Agriculture has revealed the presence of numerous grasshopper egg beds in this part of the State. However, no egg beds have been reported from central New South Wales and little trouble is expected in that area. Many landholders in the south-west have had little experience in grasshopper control work and preparations have been made for a strong control campaign as soon as hatching commences.

Argentine Ants.

The campaign against Argentine ants in the Sydney area is progressing well, although the pest has not yet been eradicated. The original infestation in the Auburn district is now almost eliminated. Since the campaign started in December 1952 more than 2,000 acres have been thoroughly sprayed with either chlordane or dieldrin. The infestation was mainly a domestic nuisance and the entomologist of the N.S.W. Department of Agriculture in charge of the campaign, Mr. G. Passfield, has stated that, as far as the average householder is concerned, the campaign has been a complete success. With the help of University students on vacation the few remaining pests in isolated spots in the area are being destroyed.

However, there have been outbreaks in other areas and Argentine ants have infested thirteen more areas around Sydney in the last twelve months. The new areas range from 2 to 23 acres and they bring the total number of infestations in Sydney to seventy-nine. Spraying with chlordane or dieldrin has apparently cleared thirty-four areas, and left only very light infestations to deal with in the remainder. Thus there is every hope that the campaign to eradicate this destructive pest from the Sydney area will be entirely successful.

Co-operative Pastoral Research at Armidale, N.S.W.

C.S.I.R.O. and the University of New England have agreed that pastoral research by C.S.I.R.O.'s Regional Laboratory at Armidale, and by the University's newly established Faculty of Rural Science, shall be closely linked, so that the resources of both can be related and used to best advantage. To bring this about a small Research Committee is being established.

For the time being, the Committee will comprise: Professor G. L. McClymont, recently appointed to the Chair of Rural Science at the University of New England, who will act as Chairman and University representative; Mr. R. Roe, the senior officer at Armidale of C.S.I.R.O.'s Division of Plant Industry, who will be Deputy Chairman and representative of the Division of Plant Industry; Dr. A. T. Dick of the Division of Animal Health and Production, Parkville, who has been appointed because of his outstanding knowledge and experience in the problems of animal and plant relationships, which will be of particular importance in the research programme at Armidale; and Mr. J. F. Barrett of the Armidale Regional Pastoral Laboratory, who will act as Secretary and Executive Officer of the Committee. The Chiefs of C.S.I.R.O.'s Divisions of Plant Industry and Animal Health and Production will be members of the Committee *ex officio*.

In this way the resources of C.S.I.R.O.'s field station at "Chiswick," including the additional laboratory facilities which are to be provided there, will be available to workers from the University, and similarly the resources and laboratories of the Faculty of Rural Science will be available to C.S.I.R.O. workers who are engaged on field experiments or laboratory researches under the general direction of the Research Committee.

The purpose of this arrangement, which has been made after most careful consideration by the Executive of C.S.I.R.O. and the University of New England, is to ensure that the research potential of both organizations is utilised fully and without wasteful competition or overlapping in the investigation of the regional problems.

Standardized Insect Names.

A recent C.S.I.R.O. Bulletin (275) lists the common names of Australian insects, together with the accepted scientific name.

This is the first official list of its kind prepared in Australia. It has been compiled by the C.S.I.R.O. Division of Entomology in co-operation with a committee appointed by the Brisbane (1951) Meeting of the Australian and New Zealand Association for the Advancement of Science. Entomologists in all States have assisted in the preparation of the list.

The list includes those insects and related pests which are of major economic importance, together with others selected on account of their abundance or striking appearance.

The scientific names used in the list are, as far as can be determined, those accepted by the recognized world authorities who have been

working on the naming of the particular categories of insects concerned. The common names are those that are most widely accepted and are most likely to become the standard common name for a species. In certain instances alternative common names which are well established in particular regions have been included.

Animal Husbandry at Sydney University.

In the notice of the 23rd Special General Meeting which was circulated to members of the Institute, a misleading statement appeared in two places. It is implied that a four year degree course in Animal Husbandry is to be instituted in the University of Sydney. This is not the case. The present proposal for the teaching of Animal Husbandry in this University is that the teaching of the various subjects concerned with animal production should be greatly strengthened in both the faculties of Agricultural Science and Veterinary Science. Students from each faculty will, as far as possible, take common courses in subjects such as Animal Nutrition, Animal Breeding and the physiological aspects of Animal Production, in which they will be required to attain a common standard.

The present proposal is that all students of Veterinary Science should take the courses in Animal Husbandry as part of the curriculum of Veterinary Science.

The more advanced of the new courses are to be elective for students of Agricultural Science. The introduction of the new material will involve specialisation to a considerable degree in the final year and to a lesser degree in the third year of the present course, for those students who elect to do Animal Husbandry. It is not proposed, however, that they be granted a separate degree, but that they graduate within the Faculty of Agricultural Science.

Artificial Rainmaking.

A series of large-scale rainmaking trials are now being carried out by C.S.I.R.O. in conjunction with the Snowy Mountains Hydro-Electric Authority. The purpose of the trials is to assess whether it is practicable to increase the rainfall over a fairly large area by releasing silver iodide at appropriate heights from a specially equipped aircraft.

If this method of seeding induces rain it will be of particular importance because it seems likely to be an economic method in practice. Other methods of seeding have been found to work with individual clouds, but they cannot be used for practical rainmaking over a large area because the cost of individually treating the large number of clouds involved would be too high.

The effectiveness of rainmaking experiments can be assessed only from a very careful analysis of precipitation recorded at the ground over an extended period of tests. Part of the area covered by the Snowy Mountains Hydro-Electric Authority has been chosen for these experiments because—

(i) the Snowy Mountains Authority is generously co-operating in providing the fullest possible data for such an analysis, from the recordings of the many rain-gauge and river-flow stations maintained by it throughout the area;

(ii) it is one in which suitable clouds occur more frequently than elsewhere; and

(iii) any increased precipitation induced would serve a useful purpose.

The target area for these trials will be the upper reaches of the Snowy River, where the Guthega Project was recently brought into operation, together with a restricted area to the south of this in the uninhabited mountain country along the upper Indi Valley to the Victorian border. The effects of the trials will be checked by comparison with the neighbouring upper Tumut and Eucumbene Rivers.

The present series of tests will be reviewed after an initial period of six months. C.S.I.R.O. does not expect a firm answer within such a short time but merely to obtain an indication as to whether they should be continued for a further period, or whether the method of seeding should be modified. The Organization is hopeful that a practicable method of modifying the rainfall over an area will be evolved in due course, but considers that such a method is unlikely to become available for several years at the earliest.

Solar Water Heaters.

The C.S.I.R.O. Central Experimental Workshops in Melbourne, have designed and developed a solar heater which utilizes the sun's radiation for heating water for domestic or industrial purposes. These solar heaters can be used economically to supplement hot water supplies from other sources, or under favourable circumstances, employed as the sole source of heat for a hot water system. They are particularly well adapted to inland areas where solar radiation is high for long periods of the year.

The solar heater consists of a flat plate absorber of blackened copper sheet with tubes soldered to it through which water circulates to an insulated storage tank. The absorber is covered by one or more sheets of glass spaced about 1 inch apart and insulated underneath with 2 inches of mineral wool. For domestic installations thermo-syphon circulation is used but for large industrial applications a circulating pump is included in the circuit.

Solar water heaters are being installed by the C.S.I.R.O. at a number of laboratories throughout Australia, and data is being collected on performance and costs under various conditions. The absorber units have been designed to be adaptable for mass production from standard fittings. They are also planned on a unit basis so that multiples of the primary unit can be grouped to form an installation of the required capacity. A solar water heater with an absorber area of one square foot per gallon per day would provide 60 to 70 per cent. of the total annual energy of a domestic hot water service in Melbourne.

Several manufacturers are considering the production of solar absorbers but they are not yet readily available throughout Australia. The installed cost is expected to be about £2/15/- per square foot excluding the storage tank. Even at this relatively high cost the unit is an economically sound proposition.

Solar installations are being increasingly studied and used throughout the world. They are being adapted for steam generation, refrigeration, air conditioning in winter and summer, and for water distillation and the production of fresh water from brine solutions. This use of solar heat for the production of fresh water has great potentiality in arid areas, and solar stills may ultimately prove the cheapest method of providing water for livestock on remote pastures.

In Australia the abundance of sunshine is one of our greatest assets, and the wider employment of solar installations in our arid zones will ensure a fuller utilization of this source of energy to improve the environment of these areas.

Genetical Society of Australia.

A meeting of the Genetical Society was held in Melbourne on 15th and 16th August. Over sixty geneticists and breeders from six states attended, and twenty papers were presented. On the evening of 15th August, Sir Macfarlane Burnet gave a lecture on the genetics of the influenza virus.

The papers presented at this meeting indicated that geneticists are at present working on important Australian material. A number of papers reported genetical work on merino sheep and subterranean clover, while several related to genetical and cytological studies on other components of improved and native pastures.

The more classical genetical studies were well represented by papers on maize and micro-organisms. Two papers reported advances in plant and animal breeding methods. These and other fields, where the geneticists can be of immediate value to breeders were the subject of discussion. Two papers illustrating evolution in progress in Australian grasshoppers evoked much interest.

Dr. Rendel and Dr. Frankel both of whom recently visited the U.S.A. reported on genetical conferences and research of note.

The meeting concluded with the showing of two interesting teaching films produced by Dr. Blackwood of Melbourne University.

The next meeting will be held in Sydney during August, 1956. The Secretary of the Society is Dr. Sobey of the C.S.I.R.O. Animal Genetics Unit, Zoology Dept., University of Sydney.

R.N.A. Pasture Competition.

The Royal National Agricultural and Industrial Association are conducting a competition to foster pasture development in Queensland. Owing to the diversity of conditions in respect to climate, soils and topography, the competition was divided into four classes.

The entries for competitions in non-irrigated sown pasture (classes 1 and 2) were allocated to either one or other of these classes by a special zoning committee, which arranged entrants according to the rainfall in thir particular zone.

Class 1—Non-irrigated sown pastures, e.g., winter or summer growing grasses and legumes;
Class 2—As for class 1;
Class 3—Irrigated pastures;
Class 4—Native pastures.

For the purpose of judging, the pastures were examined on the basis of the total pastoral value in relation to natural resources pertaining to the district. Points were allocated for the species of grasses and legumes in the sward and the compatability of the various components with each other. The presence of inferior grass species and weeds was taken into account. Further points were allocated on the general preparation and care of the area, the manner in which it was grazed, and spelled, and the way in which it was fitted into the overall farm management. The productivity of the pasture was assessed on measured cuts and general conditions of the pasture from time to time.

Two agrostologists, *Mr. S. Marriott* and *Mr. A. L. Clothier*, who are members of the Institute, were appointed judges by the R.N.A. for the 1955 competition.

N.S.W. Agriculturist Honoured.

Mr. E. P. Foster, a fruit inspector of the N.S.W. Department of Agriculture, has been created a member of the Order of the British Empire in recognition of his services to agriculture. Mr. Foster did outstanding work in British North Borneo from 1948 to early this year in connection with hemp production. He returned to British North Borneo recently to give further advice on the production of hemp.

Australian Phytochemical Survey.

The following is a short history of the Australian Phytochemical Survey, one notable result of which has been the finding of the alkaloid *Reserpine* in Alstonia constricta.

An emergency search for strategic drugs in short supply began early in 1940, at the request of the National Health and Medical Research Council and Medical Equipment Control Committee. Dr. O. Barnard of the Division of Plant Industry, C.S.I.R.O., co-operated with Professor R. D. Wright and Dr. F. H. Shaw of the University of Melbourne and Mr. H. Finnemore of Sydney University. Duboisia was subsequently developed as a major world source of hyoscine and hyoscyamine.

In the middle of 1944, Mr. L. Webb was appointed to the Division of Plant Industry as a field botanist, to make a systematic survey of Australian plants for alkaloids and other substances of therapeutic or economic value.

Towards the end of 1945, Dr. J. R. Price was appointed to the Division of Industrial Chemistry, to make detailed chemical investigations, mainly of alkaloids. Soon afterwards, the Australian Universities (e.g. Departments of Chemistry, Pharmacology or Bacteriology) began their active collaboration. Some overseas institutions later became involved in specialised pharmacological testing, since pharmacological facilities have always been inadequate in Australia.

Phytochemical Conferences were held in 1947, 1949 and 1951. These Conferences provided a more or less informal and personal means of assessing progress, and working out future plans of the co-operative survey, which grew steadily in breadth of chemical interest.

By 1949, when opening the second Conference, Sir Ian Clunies Ross was able to remark that the Survey "brought together a larger number of research and educational institutions than had probably been achieved by any other co-operative project in Australia."

The exploration of the flora for alkaloids, saponins, cyanogenetic glycosides, coumarins, pigments, etc., had yielded a rich harvest. The participation of the Division was recorded in C.S.I.R.O. Bulletins 232, 241, 268 and sundry other publications by Mr. Webb.

An increasing volume of chemical papers, and a much fewer number of pharmacological papers, showed the extent and quality of the detailed laboratory investigations of the plant materials.

Considerable overseas interest was evinced in the Australian Phytochemical Survey, which has been widely acknowledged as a model of co-operative botanical and chemical research.

Except for poisonous plants collected in southern or central Australia, the Rain forest elements of tropical north-east Australia have, so far, yielded the most attractive organic compounds and promising drugs. Countries north of Australia have lately realised the importance of surveys of phytochemical resources. These matters were discussed at length at the Eighth Pacific Science Congress in November, 1953, at Quezon, and the Second Pan-Indian Ocean Scientific Congress in August, 1954, at Perth. As the Quezon meeting, the following resolution was adopted:—

> "That in view of the growing importance of the study of all phases of medicinal plants, this Section . . . recommends . . . the arrangement of a meeting of experts to study the advisability of setting up a permanent institution for co-operative research on a regional basis in the areas where tropical conditions prevail."

Soon afterwards, Mr. Webb was appointed Australian representative on the Sub-Committee on Medicinal Plants, Pacific Science Association.

It is anticipated that overseas laboratories will shortly begin a systematic survey of the plant products already characterised in the Australian Survey. The implications of this thorough testing of the host of new substances found in Australian plants—even on the basis of probability—will be obvious.

After a time lag of 10 years reserpine has, in some measure, vindicated the confidence of the Phytochemical Survey in the therapeutic and economic potentialities of the Australian flora.

The Division of Plant Industry has had a special co-ordinating and advisory function, as well as the mechanical one of providing plant samples for analysis. Moreover, the drug and poisonous plants survey, in common with other economic botanical research, is seen at an integral part of the pattern of primary resources and land use in which the Division is intimately concerned.

Reserpine Production in Australia.

Recent C.S.I.R.O. research has shown that the alkaloid drug *Reserpine* can be obtained from an Australian plant. Previously all supplies came from the plant *Rauwolfia serpentina*, which is a native of India.

Reserpine is regarded as being valuable for the treatment of high blood pressure and hypertension.

The tree concerned—Astonia constricta (or "Bitter Bark")—is a small tree averaging ten to thirty feet in height. It is found in north-east Australia being characteristic of the drier subtropical "vine scrubs" and related transitions with eucalypt forests.

Visiting Scientists.

Recent conferences held in Australia, notably A.N.Z.A.A.S. in Melbourne and the International Wool Textile conference in Sydney, brought many distinguished scientists to this country.

Amongst those attending the Wool Conference were :—

Dr. E. G. Carter, Director of the Scientific and Technical Department of the International Wool Secretariat in London.

Prof. W. J. Astbury, F.R.S., Professor of Bimolecular Structure and honorary reader in Textile Physics at Leeds University, England.

Dr. C. C. Kritzinger, Director of the South African Wool Textile Research Institute.

Dr. G. Lazer, Director of Science and Technology at the Wool Bureau Inc. in New York.

Dr. J. G. Martindale, Principal of the Scottish Woollen Technical College, Galashiels.

Prof. Emil L. Smith, Professor of Biochemistry and Research Professor of Medicine at Utah College of Medicine.

Prof. H. G. Zahn, Director of Deutsches Wollforschungsinstitut.

Dr. A. J. P. Martin, F.R.S., and *Dr. R. L. M. Synge*, F.R.S., both of whom are Nobel Prize winners.

Dr. Martin and Dr. Synge are leading British Research Scientists in the field of protein chemistry, and were awarded the Nobel prize in 1952, for their joint invention of partition chromatography which revolutionised the chemical analysis of proteins. They addressed the Conference on the most recent developments of their method.

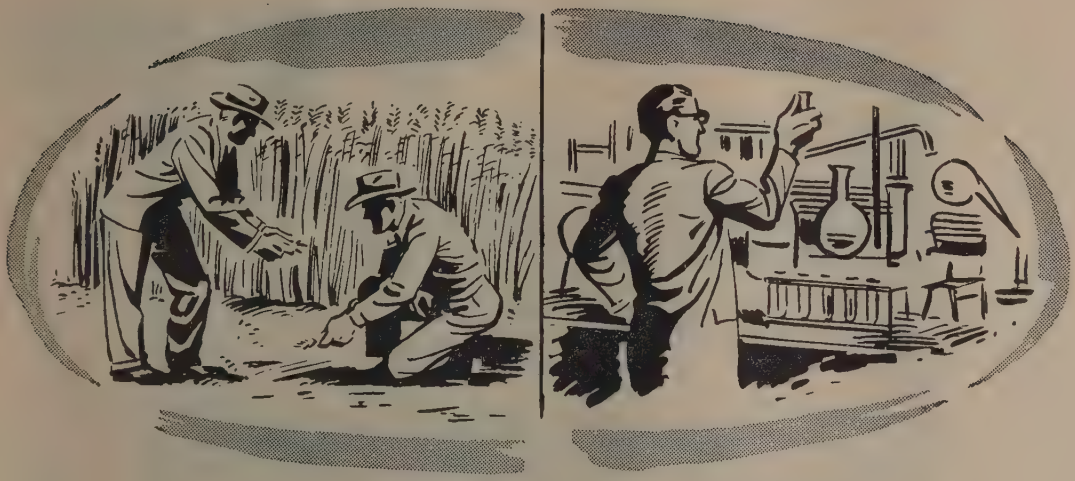
Professor P. R. Stout and *Dr. C. M. Johnson* of the Plant Nutrition Department, University of California, visited Canberra for discussions with Mr. A. J. Anderson and his team of workers. During the visit they addressed C.S.I.R.O. staff on soil nutrient problems. A summary of each talk will be found elsewhere in this Journal.

Dr. J. Melville, Director of Grasslands Division, D.S.I.R., New Zealand, spent a short period in Australia inspecting pasture work being carried out.

Dr. K. J. Mitchell, also of Grasslands, travelled through several States and delivered a number of talks to grassland workers.

Professor F. W. Went of the Californian Institute of Technology, Pasadena, visited Queensland during mid-July. Professor Went is noted for the development of the phytotron.

Dr. L. Gall, a visiting Fullbright scholar, spent several weeks in June at the Institute of Agriculture, University of W.A. where she worked on some aspects of rumen microbiology.



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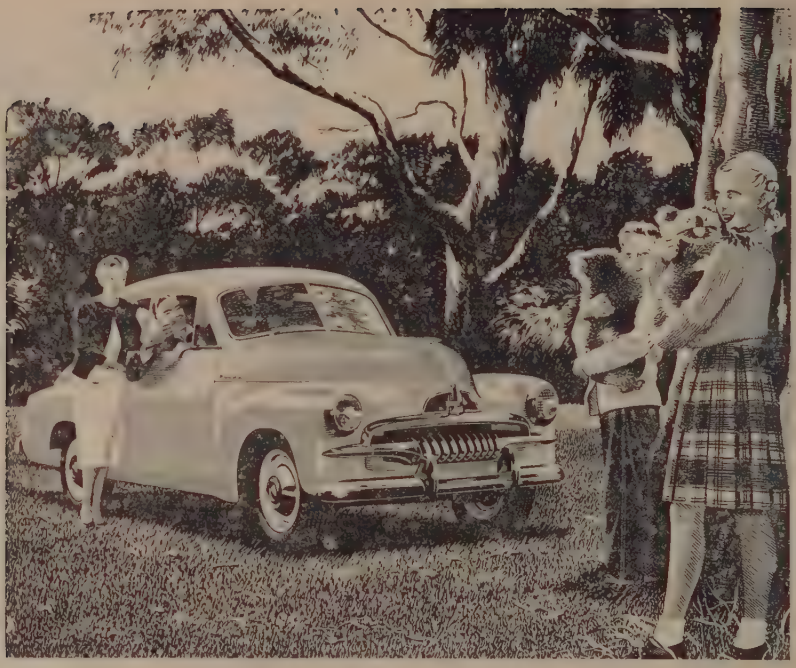

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TALKS

Dairy Research Work at Minnesota University, U.S.A.

Professor W. E. Petersen.

Prof. Petersen illustrated how new techniques and materials have aided research work. For example, the use of radio-active isotopes has shown that a modified Kreb Cycle is involved in milk synthesis in the udder.

In discussions on mastitis, Professor Petersen kept to the strict definition of inflammation of the udder. Contrary to most authorities he claimed not all mastitis was due to an active infection but to allergies. As supporting evidence he quoted the injection into the udder of dead Strep. agalactiae organisms, accepted as the causative organism in 70 per cent. of mastitis, followed by another injection 14 days later, producing an acute flare-up of typical mastitis. Other substances, such as mouse brain, egg white, etc., produced similar results.

Since the widespread use of penicillin for the treatment of mastitis, another type of mastitis with certain yeasts as the causative organisms had become quite common. The organism was probably being introduced when the penicillin was injected into the udder and its growth being stimulated in the presence of the penicillin.

Oxytocin in evacuating the udder more completely, results in a more effective penetration of antibiotics and has proved a useful adjunct in treating some of the more stubborn forms of mastitis.

Dr. Petersen touched on the potential value of superovulation and transplanted ova. At Minnesota, the nearest approach to success was an aborted calf at the fifth month. However a few successes have been reported elsewhere and he considered it only a matter of time before techniques would be developed enabling practical application.

The possibility of using cows for antibody production is under investigation at Minnesota and while it is too early to be very definite, results are very promising.

Dr. Petersen also referred to other work at Minnesota, including artificial insemination and milk fever.

"A New Synthetic Phalaris Species."

Dr. E. M. Hutton.

A chance interspecific cross, in nature, was followed by a spontaneous doubling of chromosomes to give a new species. Allopolyploidy releases a tremendous range of variability due to a new series of gene interactions. Using commercial *Phalaris tuberosa* as the female parent, a difficult cross was made with the annual *P. minor*. The F_1 was sterile; the 28 chromosomes were doubled by colchicine treatment. The resultant few seeds produced fertile plants of the new synthetic species. The population is still showing variations, particularly with respect to perenniality. The best perennial forms yield a much greater bulk of early feed than *P. tuberosa* in the year of establishment. It is proposed to call the new species *P. daviesii*.

"Cobalt and Chlorine in Plants."

Dr. C. M. Johnson.

A group of workers in the Department of Plant Nutrition at Berkeley set out to see if cobalt was essential to the growth of plants. Johnson was associated with this work. Radioactive cobalt was added to nutrient solutions and the solutions subjected to purification to remove cobalt. Measurements of the residual radioactivity of cobalt showed that the purified nutrient salts contributed less than 2×10^{-4} micromoles (0.01 micrograms) cobalt per litre of culture solution. Plants were tested with these solutions. When cobalt (5 micrograms per litre, one plant per litre) was added a 50% increase in short yield was obtained. But later experiments showed that tomatoes would not grow as well in these solutions (even with 100 micrograms cobalt per litre) as in solutions of unpurified salts. It was thought unlikely that the purification procedure introduced toxic material. Rather the cobalt salt and the unpurified salts might contain a growth factor—"element X."

By examining each of the unpurified salts for growth response, "element X" was found to be present in technical stock of KNO_3 and KH_2PO_4. Potassium chloride is the raw material from which most other potassium salts are made. Further work showed that the growth factor in technical KNO_3 was indeed impurities of chloride. Dr. Johnson outlined some of the chemical problems associated with the measurement of trace amounts of chlorine in plant tissues. The normal analytical techniques are completely unsatisfactory, despite the fact that plants require a relatively large amount (deficient leaves contained 250 p.p.m.) of chlorine. Also there is a considerable amount of chloride in the atmosphere. Special growth compartments with air filtered through activated carbon were required for critical work.

Cobalt might be essential to plants but if it was it must be below the level shown in this work. There may be some *chlorine* deficient soils in local areas with suitable climates.

Broadcasting and Television in Relation to Agricultural Matters.

Professor S. M. Wadham.

Broadcasting.

The success of agricultural broadcasting depends upon the efficiency with which the talks are designed and put over.

In a broadcast, the choice of the subject is important, but the manner in which that subject is approached is of even greater significance. The first essential is to start with the viewpoint of the listener and to avoid starting from the viewpoint of the broadcaster, who presumably knows all about his subject and unless he is careful, may convey that impression

to the listener, so that the latter feels he is being "talked down to."

In choosing a subject, its length is a most important point. A good topic can be ruined if it is opened in too broad a way. Nothing is worse than having to talk against the clock, except perhaps to convey the impression that you are doing so. As a general rule, one point of real significance for every five minutes of broadcasting is about as much as one should attempt. The same point can be made in a variety of different ways, without letting the audience appreciate the fact that you are really repeating yourself. On the other hand, the general listening public will go on listening to material in which they are not really interested, provided care is taken in such matters as enunciation and appropriate construction of the sentences.

There is a marked difference between the written word and the spoken word. Long sentences may be perfectly good English but they may be most extraordinarily difficult to read effectively. As an example, try the first chapter of the Epistle to the Ephesians. Consequently broadcast material put together in good literary style may not be as good for broadcasting as colloquial English. In other words, prepare a talk, not an essay.

All well constructed English that is pleasant to listen to has two features : rhythm and emphasis at the appropriate points. English is a rhythmic language. When properly spoken, people use cadences for the sound to convey emphasis and to give point to the construction.

The speed of speech is important. Remember the listener is trying to follow you. He is hearing the stuff for the first time; you have already seen it several times. It is no good giving him something which he cannot follow. The consequence of this is that figures should be avoided as a general rule. The audience cannot see them and the mind does not really take them in very easily. It is possible to use changes in speed during a paragraph or a page as a means of getting emphasis. This is quite different from scrambling through a talk in order to get it finished.

The importance of the pause cannot be over emphasized. It gives the listener's mind a chance to catch up. It separates one line of thought from another, and the general effect of it can be very considerable indeed. Churchill uses it with great effect.

As regards the actual technique of constructing a talk, the suggested routine is : first make a draft, then read it through, and get the sentences the right length, consider how each will be spoken and get the rhythm right, decide where emphasis is to be used on individual words and finally, on your copy to be used in the studio, mark in the rhythm and the pauses in pencil if you think it is necessary.

Each page should be timed and the length of time which it will take marked on the bottom. Then if you work with a stop watch you can see how you are going in relation to the period allotted to you.

Television.

Unfortunately, this is not likely to be available to the majority of our farmers for some years. I make no apology for opposing television, because I do not believe our economy can afford it. I do not question the fact that if we are going to have it, then it can be very useful for constructional purposes. It will give an enormous opportunity to convey ideas about material things to farmers and home gardeners, because the speaker can actually exhibit points on the material in his hand. For example, in discussing pruning matters, or weather maps and all sorts of biological features, it can be made tremendously interesting.

It is, however, entirely wrong to think that this new field will be an easy one for the demonstrator. There are a lot of new rules which he will have to learn. Presumably he will have to be made up. Certainly he will have to have rehearsals, and will not be able to walk into the studio, sit down, and do his turn in the same way that a broadcaster can. There will be grave difficulties with the script, as not many people will have the capacity to stand in the glare of television lights and talk to an unseen audience without some form of manuscript. If you put it under the desk and look down at it all the time, it will be obvious that you are doing so. If you have it on the wall behind the camera, it will take a lot of preparation and won't be easily organised. Clearly the extempore man with much courage and no fears will be very effective, but most of us won't like it much.

"Some Aspects of Agriculture in Central Africa."

C. A. Stewart.

The main purpose of Mr. Stewart's visit was to see how various types of lands, which have counterparts in Australia, are used in Africa. He paid particular attention to soils and attended the International Soil Science Congress in Leopoldville in the Belgian Congo.

Before the recent war agricultural research in Africa was on a small scale and staffs were widely scattered. Since the war much more work has been undertaken and it is now yielding results.

The five major types of country which he visited in Central Africa were :

(1) Tropical lowland rainforest belt which is not very extensive.
(2) Highland forest lands.
(3) Marginal forest with man-made savannah.
(4) Monsoonal woodland.
(5) Semi-arid and arid areas.

Mr. Stewart then spoke in detail about the agriculture in the five types of country which he had enumerated and showed a series of Kodachrome slides to illustrate his points.

In the tropical lowland rainforest the major cash crops are oil palm, cocoa, robusta coffee, but in Belgian Congo and French West Africa fresh fruits, principally bananas and pineapple, are grown for export to Europe. Rubber is an important crop in Liberia but only small areas are grown elsewhere. In parts of southern Nigeria the production of cola nut (a narcotic for local consumption) has superseded cocoa in importance. The staple crops in subsistence agriculture are yams and cassava.

The largest agricultural research centre visited in Africa is at Yangambi in Belgian

Congo. It is in the centre of a large belt of lowland rainforest that is largely not utilized at the present time. The station has a staff of 150 Europeans and approximately 3,000 natives, and approximately 9,000 acres are under crops, some being semi-commercial.

In the highland forest country of Kenya European settlers grow wheat, temperate pastures, arabica coffee and tea. The natives practise a very intensive farming for food crops such as maize, beans, etc.

In the marginal forest with man-made savannahs the very extensive grasslands have virtually no economic use. Natives fire the grasslands for hunting but agriculture is very limited because of the very low soil fertility. The natives make heaps of grass and surface soil and burn them then plant cassava and maize on the mounds with peanuts in between. Steps are now being taken to introduce cattle into these extensive grasslands but grazing will accentuate the liability to erosion and the nutritive value of the pasturage is very low.

The monsoonal woodland is very similar to parts of Northern Australia. The staple grains are maize in wetter parts, African guinea corn (sorghum) in intermediate rainfall and bulrush millet in the driest parts. The major cash crops are peanuts and cotton. Efforts at large-scale mechanized farming have generally failed but in Senegal the French have a promising scheme under way. In Madagascar and West Africa rice is cultivated with partly controlled natural flooding.

In the semi-arid and arid areas Mr. Stewart visited the Gezera Scheme in the Sudan where cotton and guinea corn and the legume *Dolichus* are grown under irrigation and Senegal where an irrigated rice project is in operation.

"The Agricultural Extension Problems on the Darling Downs."

Mr. J. L. Groom.

The speaker clarified the responsibilities of the extension officer to the grower. An extension officer is more than a salesman of ideas, for none of the rules of selling are safe to apply without sincerity. He converts research findings into a form acceptable to different growers. He passes back to the research officers, the local problems and growers' observations. Given the opportunity and the co-operation, he may sell a research team to the community and make certain that they receive the recognition that they deserve.

In Toowoomba, six modes of extension are utilised, namely, the co-operative local *press* through the farm forum pages, agricultural *radio sessions* through the national and commercial stations, *field days* with an emphasis on what the grower has done, together with grower-discussion groups, *slide evenings* and *addresses* to growers' meetings, *farm visits* which are always in demand and *office calls* by growers which provide a recorded indication of the current need of the community by means of an *enquiry record book.*

Mr. Groom emphasised that the extension officer must, at all times, find the grower's point of view, as 'no man will do anything till he wants to do it,' and 'no man will keep doing a thing unless he is satisfied with what he is doing.'

The Role of Rumen Organisms in Rumen Metabolism.

Dr. Lorraine Gall.

Dr. Gall said that bacteria are the principal agents of ruminant digestion and she described how about 25 types of organisms have been isolated, each type having a different potential rumen function. Organisms were classed as typical rumen flora if they were anaerobic and fulfilled one of the functions of (a) fibre digestion, (b) synthesis of the B vitamins, (c) utilisation of non-protein nitrogen and (d) utilisation of carbohydrates or protein.

The environment of the rumen was studied by using an artificial rumen containing a sample of the rumen contents and lucerne meal. Tests were made on the pH, anaerobic state of the sample, organisms present and the physiological potentialities of the sample. Further tests judged the activity of the sample in fibre breakdown proteolysis and determined the end products.

Work in U.S.A. and N.Z. has shown that feed type (pasture vs. concentrate) and pasture type (legumes vs. grass) change the rumen flora.

Dr. Gall said that an economic ruminant industry can be maintained if we cater for the rumen organism primarily—feeding a ruminant is really feeding a plant-like organism! To be able to do this we must know the nutritional requirements of the bacteria and we must realize that the one-celled bacteria have no storage capacity for growth and metabolic requirements. They must be supplied with all nutrients simultaneously and in correct balance otherwise excess protein or carbohydrate may be wasted.

"Phosphate Behaviour in Soils."

Professor P. R. Stout.

The phosphate in soils is to be regarded as present either as a definite chemical compound (e.g. $Ca_3(PO_4)_2$) or as absorbed on the surface of soil particles, or in both conditions. Since the sign of charge of phosphate ion is negative and the bases Ca, Mg, K, Na are positive it is evident that studies of relation between solid phase and liquid phase phosphate require special technique differing from that used for the various cations. Moreover, in view of the low solubility product of most phosphates it is evident from purely theoretical considerations that the concentration of H, Ca, Fe, etc., should largely determine the PO_4 —— concentration of the Soil Solution.

That the above is true for Ca is shown from the results of displacement if the displacement is continued *after* the successive solutions *cease* to have constant concentration. (i.e. in the so-called "Zone of Dilution.") The successive solutions become more and more dilute (owing to admixture with displacing water both in total concentration and for most elecrolytes—but the phosphate *increases.*

Soils having "high" buffering capacity (usually largely due to Ca) should have "low" PO_4 concentrations in their liquid phase. Soils which are treated with acids should increase the concentration of their liquid phases somewhat in proportion to the amounts of acid added, but the in-

creases should be much greater in soils of "low" buffer capacity than in those of "high" buffer capacity for two reasons.

(a) Because the H concentration changes more rapidly.

(b) Because the acid releases less Ca to depress the number of PO_4 —— in the soil solution.

Moreover, in both high and low buffered soils to which considerable acid is added, it seems reasonable to suppose that when the system reaches a certain point (characteristic for each system) that PO_4 ion concentration would decline because the Ca ion continues to increase without a commensurate change in pH. This has been shown experimentally.

Experiments of Teakle show how the solubility of the phosphate compounds possible in soil (Ca, Mg, Fe, Al, Mn) are influenced by pH.

Phosphate adsorbed in clay minerals.

Most highly leached soils of tropical or temperate climates do not have the quantities of sparingly soluble salts of calcium characteristic of the semi-arid regions. However, the phosphate nutrition of plants grown on such soils presents a problem of considerable importance. It can be stated that the general type of reaction of the phosphate in these soils is quite different from the reaction of phosphates in calcium dominated soils.

Kaolinitic alumino silicate minerals, and the hydrous oxides of iron and aluminium are capable of adsorbing phosphates in exchange for exposed lattice hydroxyl ions of these minerals. Adsorbed phosphate, unlike the phosphate contained in sparingly soluble salts, is not removed by Hydrogen ions. Indeed, an increase in hydrogen ion content of extracting solutions often shows the solubility of phosphate to become less. For certain acids (citrate for example) the anion associated with the acid exchanges for phosphate ions and thus can be brought into solution by an anion exchange mechanism.

It should be recognized that there are remarkable differences in the abilities of different plant species to acquire adequate amounts of phosphate from soils of this type although the reasons for this cannot always be determined.

The interpretation of data from kaolinitic soils is complicated by the fact that in addition to the anion exchanges possible the solubility of difficultly soluble phosphates has to be considered. Cationic iron, aluminium and manganese are more apt to be found in highly leached acid soils. All of these cations are capable of forming relatively insoluble phosphate compounds on the acid side of neutrality, but phosphate is released from such compounds by increasing alkalinities.

Ordinarily, soils showing anion exchange properties are *intrinsically low in their total amount of phosphate.* In addition, they have *a high capacity to adsorb phosphate ion* when it is added to the soil. Moreover, the amounts of adsorbed phosphate occurring in such soils are usually small in proportion to the total *capacity* of the system to adsorb phosphates. In soil in which kaolinite is the predominant clay mineral the adsorbed phosphate is of the order of *5%* (or less) of the adsorption capacity.

Experiments conducted on soils of this type have shown that plants suffer marked phosphate deficiency even when this figure has been raised to as high as 30% by the addition of phosphate.

The results of Teakle referred to above show that, the solubility of iron and aluminium phosphate is extremely low below pH5. In the case of iron phosphate, phosphate is released by hydrolysis increasingly as the alkalinity rises.

We cannot conclude from this that phosphate so derived would be large in the soil solution inasmuch as most soils contain so much hydrated iron oxide that the soluble phosphate would be reduced by adsorption on such material.

Professor Stout illustrated the application of the principles of soil chemistry to plant growth by citing an experiment conducted by his colleagues. He presented coloured slides of tomatoes grown in a soil which responded to applications of ammonium but not nitrate fertilisers. This response was traced to an effect of the nitrogen fertiliser on pH and hence the solubility of calcium phosphates in the soil. So that on this slightly alkaline soil the ammonium ion created enough acidity (through uptake by the plant or conversion to nitrate by soil organisms) to release phosphate from insoluble calcium phosphates.

"Some Observations on Pastures in the South Pacific."

Mr. W. W. Bryan.

Mr. W. W. Bryan showed a series of coloured slides illustrating the different types of tropical grassland and pasture to be found in the South Pacific area. These types range from humid lowland, tall bunch-type grasslands, through dry tropical lowlands to wet highland types. Grasses of the genera, *Imperata, Themeda, Sorghum, Panicum, Ischaemum, Pennisetum, Saccharum, Erianthus, Setaria* and *Microloena* constitute the bulk of the tall grass while *Cynodon, Paspalum, Brachiaria* and *Axonopus* are prominent among the grasses of shorter habit. In a range of rainfall from forty inches to more than two hundred inches, and of elevation from sea-level to over eight thousand feet, it is to be expected that the range of pasture types will be great. The problem is not to find useful grasses, but to ensure adequate nutrition for them, especially with regard to nitrogen. Great interest therefore centres on tropical legumes. A wealth of species occurs in the region, but in most areas the proportion of legumes in the pasture is low to very low. A notable exception is found in the legume-rich communities under coconuts. The chief limitation to high legume production is probably phosphate. Thus the main problem to be solved before pasture management and stock-raising studies can be undertaken involves nutrients, species and mixtures, and especially the legume component thereof.

"A Serious New Disease of Cowpeas."

Mr. G. S. Purss.

A stem rot of cowpeas, caused by a species of *Phytophthora,* has become widespread in occurrence since its appearance in North Queensland, early in 1952. The two popular varieties, Poona and Reeves, are susceptible to the disease. Affected plants wilt and the leaves turn yellow. The root system decays and a lesion extends up the stem often reaching the tip of the plant.

The fungus produces abundant oospores in the diseased tissues. Evidence indicates that the disease is soil-borne. Local varieties, Cristaudo and Giant have a measure of field resistance. Three varieties—Black Eye 5, Chinese Red and an unnamed introduction possess a very high resistance. A solution to the problem lies in the incorporation of resistance into the best local varieties by plant-breeding.

Weaner Unthriftiness Problem in South Australia.

Mr. W. S. Smith and Mr. C. Mulhearn.

Mr. Smith gave a general account of the problem. He said that in certain areas unthriftiness could not be attributed to any usual cause such as parasites or undernutrition.

Mr. Mulhearn described investigations at Waitpinga and part of Kangaroo Island. In each case the problem develops on ironstone soils with sub-clover/rye grass pastures which are 15 years old. The problem does not occur where lucerne or summer fodder crops are fed.

Lambs at first appear normal, but from weaning in October-November to June-August the weaners lose condition, become emaciated and 400 out of 600 on trial property have died. Once they attain age of 2-tooth, the survivors grow well and give no further trouble.

Drenchings and post-mortems suggest that parasites are not a cause. No response has been obtained by drenches of the trace elements cobalt, copper, manganese, iron, zinc or nickel or of vitamins A and D. Potash drenching has shown no effect nor has potash top dressing although it is probably too early to expect a response.

Investigations are continuing.

"A Leaf Shrivelling Virus Disease of the Tomato."

Mr. O. W. Sturgess.

For many years, a peculiar disease of the tomato has been observed within tomato plantings throughout horticultural districts of Queensland. The disease is caused by a previously unrecorded virus, which is tentatively named the *tomato leaf shrivelling virus* (*T.L.S.V.*). The virus is readily transmitted by the aphid vectors, *Myzus persicae* Sulz., *Aphis gossypii* Glov. and by mechanical methods. Affected plants show a systemic, diffuse light green—dark green terminal rugosity, together with a yellowing of the basal portions of terminal leaflets and a systemic downwards and inwards recurving of the leaves and leaflets. The recently expanded leaves develop an interveinal and veinal necrosis on the under-surfaces of the leaves. Fully expanded leaves are of harsh appearance and brittle texture and may show a variable marginal and spot necrosis. The lower expanded leaves yellow, become necrotic and shrivel. The shrivelled leaves remain attached to the stem. Glasshouse studies indicate that the T.L.S.V. belongs to the potato virus Y group. Physical properties and host range support this hypothesis with one exception. It has not been possible to infect mechanically, virus-free potato varieties, which are susceptible to potato virus Y. A second important field disease is the dual virus infection of the tomato by *aucuba* and *ordinary strains* of *tobacco mosaic virus* and *strains* of *T.L.S.V.* Plants affected by the virus complex exhibit a varied reaction which is governed by the order of virus infection, the stage of plant development and field temperature conditions. The testing of tomato varieties in the field and glasshouse for virus tolerance has been initiated.

The Grape Breeding Programme in California.

Professor H. P. Olmo.

Prof. Olmo outlined the techniques and methods which have been developed at Davis since the programme was started in 1936.

Prof. Olmo indicated the possible progress of the 4,000 seedlings from crosses made in 1954. In 1955 the seeds were germinated in nursery flats and at the two leaf stage were transplanted to outdoor beds. In 1955 the seedlings would be planted out in a seedling block and the main fruiting and growth records would be taken in the years 1960 and 1962. These records would allow a selection of about 2 in 1,000. A plant selected in 1960 would be planted out in a trial block, together with the standard varieties with which it is to be compared, in a replicated randomized arrangement. From 1963 to 1965 its performance would be assessed and about 1 in 10 of such selections are suitable for naming, describing and commercial release if proven free from viruses. By 1968 the variety would be in commercial production.

In 1948 the first 5 varieties were released and in 1956 10 more are due for release. The main projects are breeding for seedless table grapes, new table types and juice types, high yielding wine grapes of good quality and disease and pest resistant varieties. Some smaller projects such as an easily shedding canning grape are supported by industry.

As well as breeding commercial varieties basic theoretical study is being made of tetroploid varieties, the use of the native American Muscadine which is extremely vigorous and immune to most diseases and pests and the inheritance of wine pigments, flavours and acids.

Identification and Measurement of Radio-active Isotopes in the Atmosphere at Adelaide, S.A.

Professor P. R. Stout

Prof. Stout commenced by saying that his interest in radio-activity in the atmosphere arose out of some work on the chlorine nutrition of plants carried out by Dr. C. M. Johnston. In some of their experiments, less chloride was recovered in the plants than was expected. It was therefore considered that chloride could be disappearing as a volatile substance such as nitroxyl chloride or ethylene chloride. In order to test this hypothesis plants were grown in a desiccator and the air circulating through the desiccator was collected in a line of adsorbers. The precipitated silver chloride was found to be radio-active but the activity did not persist over a weekend. A large activity was then obtained just by passing air through a filter paper. There was considerable activity and the half life of 50 minutes was found. The half life of 50 minutes precluded any influence from A-bombs in Nevada. The activity was found at Riverside, also at Palmerston North.

Experiments conducted at Berkeley and Riverside, California; Palmerston North, New Zealand; Canberra, A.C.T.; and Adelaide, South

Australia, reveal atmospheric radio-activity to be universal. Radio-activity can be extracted from the atmosphere at any time by simple filtration. The atmospheric burden of radio-activity resulted from the diffusion of Rn^{220} and Rn^{222} from soils and rocks which, upon further radio-active decay, give rise to the following radio-active isotopes in the atmosphere—Po^{218}, Po^{216}, Po^{214}, Po^{212}, Bi^{214}, Bi^{212}, Bi^{210}, Pb^{214}, Pb^{212}, Pb^{210}, Tl^{210} and Tl^{208}. Attention has been focused upon the lead isotopes Pb^{214} and Pb^{212} and the Bi isotope Bi^{213}, each of which has been identified by chemical methods with radio-tracers. From data obtained from these isotopes the amounts of other isotopes within their decay sequence have been established quantitatively.

During the course of his studies in Adelaide Professor Stout noted that the counting rate varied with the weather. When the weather was fine or windy, activity was much lower than under still and cloudy conditions. It was therefore thought that the activity was tied up with conditions of air stagnation and hence smog. The Pb^{212} found in the atmosphere had to come from thoron which in turn came from thorium and hence since the quantity of the material was considerably higher than that in California it was thought possible that a high thorium content in coal might give rise to a high activity when smog conditions were encountered.

The air sampled at the Mile End railway yards had no greater activity than that in the city. Professor Stout pointed out that recently in "Nature," thoron derivatives had been reported in air near London and as early as 1905 an Italian had reported thoron derivatives in the catacombs of St. Agnes.

At this stage Professor Stout became alarmed at the intake of activity by the human body. A sheep was kept for several weeks and then sacrificed. Only 14% of the estimated intake of radiation was accounted for and this was distributed throughout the body of the animal.

It was found that there was no correlation between smog as measured by blackening of the filter paper and the measured radio-activity.

There appeared to be a good correlation with the wind; if the wind came from over the sea a low count was obtained and if overland, high. The count depended on the velocity and distance the air had travelled overland. Prof. Stout said that he considered land to be the generator. He calculated that there was 1 gram of lead in the earth's atmosphere, that 108 tons of thorium would be required to put it there and that there would be this amount of thorium in the surface millimetre of land.

Prof. Stout considered that diffusion of the noble gas thoron may be a useful tool in studying soil structure.

"Some Notes on the Safflower."
Mr. G. H. Allen.

Safflower (*Carthamus tinctorius* L.), a plant native to semi-arid areas of India and North Africa, has been grown experimentally in Australia for many years and more particularly in Queensland since 1945. Safflower is a long season crop requiring over 200 days, during Australian winters. Mr. Allen commented on the results obtained in 1954 from safflower plantings at Hermitage, Ayr and Biloela Regional Experiment Stations. Planting rates used in Queensland were about 50 lb. per acre with combine drills. The crop is harvested with wheat machinery, but it is essential to reduce the drum speed to avoid seed-cracking. The stout stems of some crops tend to pack up the harvester. In certain areas, the plant may be affected by root rot or rust or aphid damage. Seed yields varied from failures and up to 350 to 750 lb. per acre under normal farming conditions, and up to 1,200 lb. per acre following long fallows. Yields from 1,750 lb. up to 2,250 lb. per acre were common in irrigated plantings. There is no market outlet for safflower seed at present. Safflower oil is an edible oil and may be used as a drying oil for paints and also for soap manufacture. Early indications are that Queensland yields wil allow a profitable return which compares favourably with the weakening wheat price. Questions regarding water use, effect on soil fertility and the volume of the safflower in crop rotations are being studied. This year, trials are planted at Hermitage, Biloela, Ayr and Millaroo.

"Silage for Western Sheep Areas."
Mr. P. J. Skerman.

In 1953, the University of Queensland extended its wool research programme into crop growing for drought feeding of sheep in the under 20 inch rainfall belt of the State. It commenced with sorghum plots at Charleville, Richmond, Muttaburra and Blackall. Fallowing produced dividends, and yields of up to 62% greater than normal were obtained. Soil moisture studies showed that, in the initial year, 8 inches of stored moisture grew the crop. In adjacent fallowed land, the nitrate-nitrogen built up to the equivalent of 26 lb. of nitrogen, as nitrogen per acre during the 74 days growth of the sorghum plots. Several graziers, who have adopted fodder conservation, have up to 5,000 tons of sorghum silage underground at the end of the season. With a proportionate addition of a smaller protein supplement, this amount of silage is sufficient to feed 10,000 sheep each day for a full year's drought. Sorghum experiments including inter-row legumes are being conducted to obviate the need for a protein supplement. Mr. Skerman screened a series of kodachrome slides illustrating fodder conservation.

"Nutritional Disorders of Plants in the Stanthorpe Area."
Mr. F. Chippendale.

The following deficiency groups were illustrated by colour transparencies :—boron deficiency in apple fruit and apple shoots, iron deficiency in apple trees and orchard weeds, magnesium deficiency in dark and light skinned grape varieties with and without iron as a complicating factor, zinc deficiency in apple trees and molybdenum deficiency in beans, celery and cucurbits. The latter deficiency was considered to cause the greatest economic loss in the Granite Belt. Its seriousness has been recognised only recently. A spectacular disorder of the Santa Rosa plum was proved to be due to sulphur deficiency by Mr. T. Bowen, the local Horticulturist.

PERSONAL NOTES

Australian Capital Territory.

Dr. O. H. Frankel has returned from a three months visit to U.S.A. and the U.K. While in the U.S.A. he attended the Cold Spring Harbour Symposium on "Population Genetics" and Brookhaven Symposium on "Radiation Genetics."

Mr. A. J. Anderson has returned from a short visit to the U.S.A. where he was a Guest Speaker at the McCollum-Pratt Symposium on Nitrogen Metabolism held at the Johns Hopkins University from June 21-23, 1955.

Mr. C. H. Williams, of the Division of Plant Industry has arrived back in Canberra after spending approximately twelve months in the U.K. Unfortunately he was ill for a portion of his time overseas and returned direct from the U.K. rather than via U.S.A. as originally planned. Mr. Williams spent most of his time at the Macaulay Institute and visited research institutes in the U.K. and on the Continent.

Mr. T. G. Campbell, Research Officer, Division of Entomology, C.S.I.R.O., returned to Canberra in June after spending six and a half months in Fiji.

While there, Mr. Campbell acted as Senior Entomologist to the Department of Agriculture and as adviser on entomological matters to the Coconut Pests and Diseases Control Board, the statutory body controlling the campaign against rhinoceros beetle. During the course of his journey to Fiji, Mr. Campbell visited the headquarters of the South Pacific Commission in Noumea and on the return journey paid a brief visit to Wellington, to contact officers of the Department of Agriculture and inspect the recently established plant quarantine station and laboratory.

There have been a number of new appointments to the Division of Plant Industry, C.S.I.R.O., Canberra:—

Dr. J. E. Falk, a senior biochemist, returns to Australia from England where he was a Fullerton Research Fellow of the Royal Society and leader of the Nuffield unit at the University College Hospital, London.

Dr. J. B. Griffing, a geneticist, comes originally from Iowa, U.S.A., and for the last two years has worked with Sir Ronald Fisher at Cambridge.

Mr. D. L. Hayman, who has just completed a studentship under Professor Catcheside at Adelaide, also joins the Genetics Section.

Mr. N. A. Walker, a biophysicist, comes from Hobart where he studied under Professor McAuley.

Dr. D. J. Cosgrove, a soil chemist, comes from England where he was research chemist at the Cereal Research Station, St. Albans.

New South Wales.

Dr. E. T. Edwards has been appointed to the new position of Public Relations Officer at the New England University, Armidale, N.S.W. Dr. Edwards has had a varied career firstly as a plant pathologist in the N.S.W. Department of Agriculture, later as an agricultural journalist and most recently as a pest control specialist with Messrs. Houghton & Byrne Pty. Ltd. in Sydney. It will be recalled that Dr. Edwards played an important part in the establishment of the Institute in New South Wales.

Dr. J. D. Colwell has been awarded the degree of Doctor of Philosophy from the University of Aberdeen, Scotland. His thesis dealt with phosphate solubility and retention in some Australian soils. Dr. Colwell worked for two and a half years at the Macaulay Institute of Soils Research in Scotland as a Walter and Eliza Hall Agricultural Research Fellow from the University of Sydney. Following his recent return from Scotland he took up duty with the Soil Survey Unit of the N.S.W. Department of Agriculture as a soils chemist.

Miss D. E. Shaw, Plant Pathologist at the University of Sydney has been further investigating leaf diseases of cereals at the Dominion Rust Laboratory at Winnipeg, Canada as a Walter and Eliza Hall Scholar. Miss Shaw has been admitted to the degree of Ph.D. for her work and has also received a grant from the Rockefeller Foundation to enable her to visit research centres in the U.S.A. before she returns to Australia.

Mr. D. J. Goodchild has been awarded a Fulbright Fellowship and will be proceeding to the University of California, Los Angeles, where he will take up a position as teaching assistant in botany and continue his work on virus synthesis.

Mr. W. M. Curteis has accepted appointment as Director of Plant Industry, Department of Territories, in the Northern Territory. He was a Senior Agronomist in the N.S.W. Department of Agriculture and previously spent two years in the North West Frontier Provinces of Pakistan, advising on crop growing, under the Colombo Plan.

Queensland.

Dr. N. T. M. Yeates of the Physiology School, University of Queensland, was invited by the Afrikander Cattle Breeding Society to visit South Africa. He delivered a paper on *"Livestock Adaptation in Tropical and Sub-Tropical Environment"* at their national exhibition of Afrikander cattle. Dr. Yeates left by air-travel for South Africa during the first week in May. After the exhibition the society transported him to various parts of the country to view their stock.

Mr. A. F. Bell, Under-Secretary, Department of Agriculture and Stock, returned from New Guinea during early April. He is chairman of

the Standing Committee on Agriculture of the Australian Agricultural Council. The Standing Committee held a meeting in New Guinea. They visited Port Moresby, Rabaul, New Britain and Kavieng and on the highlands the committee travelled from Lae to Goroka.

The Senate of the University of Queensland has invited Mr. Bell to deliver the *John Thomson lecture* in late September. The lecture will deal with the *"History of the Sugar Industry in Queensland."*

Mr. F. Chippendale of the Department of Agriculture and Stock has been appointed Senior Agronomist in charge of tobacco. Formerly Senior Soils Technologist in the Department, Mr. Chippendale has for some years been closely associated with quality investigations in all of the main tobacco-growing districts of the State. He will plan and supervise the work at the three tobacco experiment stations being developed. These stations are at Parada (near Mareeba), Millaroo (Lower Burdekin) and Inglewood.

Mr. B. R. Champ, Entomologist, was awarded one of the two major post-graduate research travelling scholarships for 1955 by the Gowrie Scholarship Trust Fund. The scholarship is for two years and will enable him to engage in entomological studies at the Imperial College of Science and Technology, London.

Mr. S. Marriott, Senior Agrostologist, spent a month in the buffel grass areas of Western Australia and of north-western Queensland, searching for strain differences and examining methods of establishing and managing buffel grass. Experience in Western Australia supports the findings of Queensland agrostologists that buffel grass can be established most quickly when some cultivation is undertaken.

Mr. H. Hasseler, Chemist with the Department of Agriculture and Stock at Atherton, has taken charge of the plant nutrition laboratories at Ayr and Atherton. *Mr. B. J. Crack* has been transferred from Brisbane to Ayr to operate the Ayr nutrition laboratory.

Dr. R. F. N. Langdon, Senior Lecturer in Plant Pathology at the University of Queensland, *Mr. T. McKnight,* Senior Pathologist, and *Mr. G. S. Purss,* Pathologist, both of the Queensland Department of Agriculture and Stock, attended the Plant Diseases Conference held at Hawkesbury Agricultural College from late June to early July, 1955.

During 1956, *Professor D. A. Herbert,* Professor of Botany and Dean of the Faculty of Science, University of Queensland, will spend his twelve month study leave period visiting Universities and Botanical Institutes within the United Kingdom and the Continent.

Mr. A. L. Clothier, who is an agrostologist with A.C.F. and Shirleys Fertilisers Limited, was recently transferred from Warwick to Brisbane.

Mr. T. B. Paltridge, Principal Research Officer of C.S.I.R.O.'s Plant and Soils Laboratory, Brisbane, severed a twenty years' association with Queensland's pasture problems when he sailed on the 26th July to take up an appointment with the Coconut Research Institute at Lunuwilla, Ceylon.

Mr. Paltridge's services have been made available to the Ceylon Government by the Commonwealth under the Colombo Plan. His appointment is for three years. The work that he will undertake is part of a scheme to produce more meat and milk by developing a pasture that will grow under the shade on a coconut plantation without detriment to the palms.

Mr. Paltridge is best known for his work at Cooper's Laboratory, Lawes, with row lucerne and Paspalum scrobiculatum. His appointment to Queensland in 1935 was the forerunner of the tremendous development in pasture research which has been undertaken by C.S.I.R.O. in this State, and with which Mr. Paltridge has been closely associated.

South Australia.

Two appointments have been made in the newly-formed Division of Extension Services and Information of the Department of Agriculture as follows :—

Mr. P. C. Angove, formerly Senior Agricultural Adviser of the Department of Agriculture, has been appointed Senior Extension Officer and *Mr. D. T. Kilpatrick,* formerly Senior Horticultural Adviser of the Department of Agriculture, has been appointed Senior Information Officer.

Mr. T. C. Miller, formerly Assistant Superintendent of Horticulture of the Department of Agriculture of Western Australia, has been appointed Chief Horticulturist of the South Australian Agriculture Department.

Mr. C. R. Kleinig, formerly of the Agronomy Department, Waite Institute, has been appointed to the Oil Seeds Investigation team of the C.S.I.R.O. Division of Plant Industry stationed at Waite Institute.

Mr. D. Symon of the Agronomy Department, Waite Institute, will spend a year's study leave in 1956 at the Scottish Society for Research in Plant Breeding.

Western Australia.

Professor E. J. Underwood has been elected President of the National Society for the Prevention of Tuberculosis in Australia.

Mr. A. J. Millington, Reader in Agronomy at the Institute of Agriculture, University of W.A. has had conferred upon him the degree of D.Sc. (Agric.). His thesis was titled "A Study of Some Aspects of Australian Wheat Production."

Mr. Stan Hardisty, Horticultural Branch, Dept. of Agric. has been transferred from Perth to Bridgetown.

Mr. K. Whitely, Horticultural Branch, Dept. of Agric., has been transferred from Perth to Albany.

Tasmania.

Mr. C. A. Holland, Chief Extension Officer of the Tasmanian Department of Agriculture, returned in July from a visit to the Philippines as a member of the Unesco Technical Assistance Mission. Mr. Holland specialised in Agricultural education as a member of a six man team. His work was to bring closer, the teaching of Agriculture in High Schools and improvement of Agricultural practices in the village.

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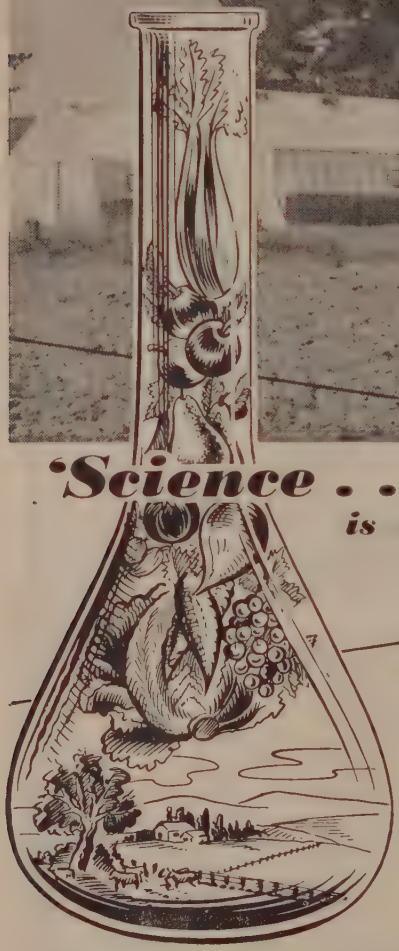

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Victoria.

Mr. J. Shipton, Chief Food Technologist of the Department of Commerce and Agriculture, is visiting the U.K. and U.S.A. to study developments in the dehydration of foodstuffs, particularly vegetables, and especially as applied to Service use. He has been invited to attend a Commonwealth Defence Materials Conference in London and will contribute to the discussions on defence foodstuffs.

Mashed potato powder as produced commercially in England is, for example, a recent development which could have a valuable application in Australia. It is a high quality product which is readily re-constituted with hot water to produce a very acceptable mashed potato. This potato powder, if it can be produced at a competitive price, would be popular in this country.

Mr. A. B. Cashmore has left C.S.I.R.O. Animal Health and Production to become Technical Secretary to the new Nicholas Institute, Burnham Beeches, Sherbrooke.

Dr. I. F. Phipps of I.C.I.A.N.Z. is returning from a tour of the United States and Britain.

Mr. R. Carne is in Victoria on six months leave from his position of District Agricultural Officer in Lae, New Guinea.

Mr. L. L. Stubbs, Plant Pathologist with the Victorian Department of Agriculture has left Melbourne to take up a Commonwealth Fund Fellowship. He will work at the University of California on virus problems and, before returning to Australia in twelve months time, will visit research institutions in America and England.

BRANCH NOTES

Australian Capital Territory.

A meeting was held on 26 May at which the following films were shown:—"Fine Feathers," "Makers of Wine," "Blue Ice" and "Australian Diary."

A meeting was held on 21 July at which Mr. G. A. Stewart, Acting Officer in Charge of the Land Research Section of C.S.I.R.O. spoke on "Some aspects of agriculture in Central Africa."

New South Wales.

The main business of the meeting on 29th April was a very successful symposium on "The Flood Problem in N.S.W." The large attendance of 81 members and visitors and the good discussion which followed the addresses demonstrated the success of this type of meeting programme. The texts of the addresses will be published elsewhere in the Journal. At the meeting on 19th May Professor G. Hart and Professor R. L. Crocker addressed 40 members and visitors on some aspects of primary production in California.

Mr. E. J. Breakwell has been appointed the corresponding member for N.S.W. on the Institute's Agricultural Engineering Sub-committee formed earlier this year and the Branch looks forward to some constructive suggestions in this important and neglected field of agricultural activity.

The Branch Committee is considering what steps might be taken to increase the influence of the Branch in formulating N.S.W. agricultural policy. It is felt that the Branch could make worthwhile contributions through such bodies as the Royal Agricultural Society Agricultural Bureau and the Junior Farmers' Organization. It is felt too that Branch membership as well as Branch activity should be increased and a recruitment sub-committee is proposed.

Proposal for Creation of Sub-branches.

The Management Committee of N.S.W. Sub-Branch have been examining the possibility of developing further Sub-Branches in suitable areas, where membership is sufficient to conduct an active Sub-Branch.

To survey the possibility of creating a Sub-Branch at Armidale, arrangements were made for the Executive Officer, Mr. J. A. Roberts, to visit Armidale. It is likely that steps will be taken to form a New England Sub-Branch when his report is received.

The Institute and Sydney University Agricultural Graduates' Association.

On the occasion of the visit of interstate plant pathologists for the Plant Disease Conference held at Hawkesbury Agricultural College, the Sydney University Agricultural Society and the Institute entertained visitors and members at a buffet tea at the Sydney University Union on 1st July.

This was followed by a meeting at which Dr. Millikan, Deputy Chief Biologist, Department of Agriculture, Victoria, gave an illustrated address on "Recent Advances in Plant Pathology in U.S.A." Dr. C. P. Magee followed with a lecture on "Impressions in Plant Pathology in U.K."

Members were treated to an excellent review in these addresses of current advances in plant pathology and crop protection overseas.

Queensland.

At a Branch meeting held in April four members, *Dr. E. M. Hutton* and *Messrs. G. S. Purss, P. J. Skerman* and *F. Chippendale* contributed to a varied "notes and exhibits" evening. Titles of papers were, respectively:—

"A new synthetic phalaris species."
"A serious new disease of cowpeas."
"Silage for western sheep areas."
"Nutritional disorders of plants in the Stanthorpe area."

An address to the May meeting on "The Agricultural Extension Problems of the Darling Downs" was given by a guest speaker, *Mr. J. L. Groom.* Slides were screened with annotations during the address.

The June meeting was devoted to a second series, for the year, of "notes and exhibits." Three members, *Messrs. G. H. Allen, O. W.*

Sturgess and *W. W. Bryan*, addressed the meeting. Titles of papers were, respectively:—

"Some Notes on the Safflower."

"A Leaf Shrivelling virus disease of the tomato."

"Some Observations on Pastures in the South Pacific."

ERRATUM.

The position of *Honorary Secretary-Treasurer* of the Branch was incorrectly reported in the previous issue of the Journal. The corrections are as follows :—

Honorary Secretary-Treasurer—Mr. G. J. P. McCarthy.

Asst. Honorary Secretary-Treasurer—Mr. S. A. Waring.

Tasmania.

On the 6th June, *Mr. F. W. Hicks*, Superintendent of Extension of Technical Services of the Tasmanian Department of Agriculture, gave an illustrated lecture on his recent trip to England and the U.S.A.

On 8th July, *Professor Barber* spoke on "Recent Advances in Genetics."

South Australia.

Instead of the usual May meeting, members were invited by the Australian Veterinary Association to hear an address by Professor W. E. Petersen, Professor of Animal Husbandry, University of Minnesota, U.S.A. Dr. Petersen addressed a "capacity house" on current work at the University of Minnesota.

On 10th June, two members of the Department of Agriculture, Mr. W. S. Smith and Mr. C. Mulhearn, combined in an address on "Weaner Unthriftiness."

On 8th July, another "capacity house" gathered to hear Prof. Perry R. Stout's address on "Identification and measurement of radioactive isotopes in the atmosphere at Adelaide, South Australia."

Western Australia.

During the year 2 of the monthly meetings of the branch are to be devoted to papers presented by members of the branch. A prize of £5 will be awarded to the member presenting the best paper as regards subject matter and presentation.

On the 17 June a joint meeting was held with the society of Dairy Technology at which Dr. Lorraine Gall gave an address titled "The Role of Rumen Organisms in Rumen Metabolism."

On the 15th July Prof. H. P. Olmo, Professor of Viticulture, University of California, addressed the branch on "The Grape Breeding Programme in California."

Victoria.

The Twentieth Annual General Meeting was held on 20th May, 1955. The following office bearers were elected.

President — Mr. A. L. Tisdall.
Vice-President — Mr. C. E. Cole.
Hon. Secretary — Mr. J. P. Brien.
Hon. Asst. Secretary — Mr. W. T. Parsons.
Hon. Treasurer — Mr. J. V. Mullaly.
Committee — Mr. T. S. Bellair, Mr. H. E. Harding, Mr. R. O. Kefford and Dr. C. R. Millikan.
Hon. Recorder — Mr. J. J. Lenaghan.
Hon. Sub. Editor — Miss I. J. Stewart.
Immediate Past President — Mr. B. F. McKeon.
Professor of Agriculture — Professor S. M. Wadham.

Of interest to other Branches are the Sub-Committee activities which were reported at the Annual General Meeting.

Agricultural Notebook. This project has been accepted as one on behalf of the Institute as a whole. The Victorian sub-committee has accepted the responsibility for preparing and editing the material. Contributions have been sought from many members of the Institute in various States and much excellent material is already in hand. Progress with editing, always a long job, is fairly well advanced, and the Notebook should reach the final stages of compilation at the end of this year. The sub-committee has been very gratified by the prompt and painstaking attention given to their sections by contributors.

Conservation of City Wastes. A report of this sub-committee will be published in the Journal as the matter is considered of wide interest.

Publicity and Public Relations sub-committee has carried on its work of distributing "Careers in Agricultural Science" together with circular letters to schools. An article was prepared for "Juniors Journal," on behalf of the Institute, for distribution to all Australian schools.

As well as press releases, broadcasting and films are being explored as avenues of publicity.

Undergraduate Affairs. The main activity of this sub-committee was the individual interview and discussion with members of the Fourth Year. The majority of students took advantage of this service. A follow-up of the 1953 students indicated that all seemed active and happy in their work.

Agricultural Engineering. Council decided to set up an Agricultural Engineering Sub-committee with the following terms of reference:—

(1) To prepare information relating to Agricultural Engineering for the guidance of Council.

(2) To co-operate with the Institution of Engineers, Australia, to identify problems of agriculture which would benefit by the application of engineering.

(3) To make recommendations to Council to assist in the development of agricultural engineering in Australia.

Council proposed that the Sub-committee consist of members nominated from the Victorian Branch, with a corresponding member nominated from each of the other branches. The Committee is at present being formed.

Other Sub-Committees. Programme, Membership, Salaries and Status, and Social have also been active throughout the year.

Branch Newsletter. This is circulated approximately bi-monthly and continues to be effective and popular.

Showtime Supplement. This was published in the "Age" on September 24, 1954. Unfortunately owing to newspaper shortage it will not be possible to publish a 1955 supplement.

Joint Session with A.N.Z.A.A.S. On 19th August, 1955, a symposium on "Efficiency in Agriculture" was held as a joint session by the Institute and Section K of A.N.Z.A.A.S. This was followed by a highly successful social function.

A Meeting held on 11th July was addressed by Mr. J. G. Crawford, C.M.G., M.Ec., Secretary of the Department of Commerce and Agriculture, on "The Present Economic Position of Australian Agriculture."

FINANCIAL STATEMENT

Sir,

We have audited the accounts of the Journal for the year ended 31st December, 1954, and attach a Statement of Receipts and Expenditure which, in our opinion, correctly reflects the transactions during the period according to the books of account and the information and explanations supplied to us.

Income and Expenditure Statement. In terms of the recommendation made in our last report a Statement of Income and Expenditure is now submitted in lieu of a Statement of Cash Receipts and Expenditure.

The great advantage of the Income and Expenditure Statement is that the Institute now has the information as to the relatively small grants necessary to maintain a Journal so essential to those interested in Agricultural Science.

Balance Sheet. The only item that may be subject to alteration is that of Sundry Debtors. A small proportion of the amount owing under this heading dates back some time and it is just possible that all accounts owing will not be received.

Now that the accounts have been presented in the new form it would be of assistance to all concerned if your Mr. Roberts could continue to write up the books for at least some years to come.

Yours faithfully,
CLEVELAND, SON & HISLOP,
Chartered Accountants (Aust.).

THE JOURNAL OF THE AUSTRALIAN INSTITUTE OF AGRICULTURAL SCIENCE.

Statement of Income & Expenditure, Vol. 20, *1st January,* 1954, *to* 31*st December,* 1954.

Expenditure.		*Income.*	
Printing and Publishing	£1,223 10 7	Subscriptions	£372 8 11
Postage	35 0 4	Advertising	198 18 3
Reprints	160 1 3	Reprints	173 9 8
Stationery	19 12 1	Back Numbers	33 15 1
Office Bearers' Expenses	15 12 8	Interest from Commonwealth Savings Bank	5 5 1
Audit Fees	4 4 0	Deficit on Year's Transactions	701 12 9
Typewriting, Purchase Back Numbers and Sundries	27 8 10		
	£1,485 9 9		£1,485 9 9
Deficit on Year's Transactions	£701 12 9	Grant for 1954 from Rural Credit's Fund, Commonwealth Bank	£200 0 0
		Grant for 1954 from Aust. Inst. of Agricultural Science	400 0 0
		Balance carried forward	101 12 9
	£701 12 9		£701 12 9

CLEVELAND, SON & HISLOP,
Chartered Accountants (Aust.).

Balance Sheet as at 31st December, 1954.

Liabilities.				*Assets.*				
Sundry Creditors.				Commonwealth Savings Bank				£368 9 2
Printing and Publishing Vol. 20, No. 4	£345 14 9			Petty Cash on Hand				2 19 8
Reprints, Vol. 20, Nos. 3 and 4	93 6 10			Sundry Debtors:				
Postage, Vol. 20, No. 4	12 8 1			*for Subscriptions:*				
Sundries	7 2 10			Vol. 16 (1950)	£2 10 3			
		£458 12 6		„ 17 (1951)	3 8 6			
Subscriptions Paid in Advance		107 15 9		„ 18 (1952)	18 4 0			
Capital Fund of Journal				„ 19 (1953)	29 5 10			
Less Deficit on Year's Transactions (after crediting Grants Received)		138 4 2		„ 20 (1954)	25 1 0			
						£78 9 7		
				for Advertising:				
				Vol. 15 (1949)	£8 8 0			
				„ 16 (1954)	7 11 2			
				„ 20 (1954)	59 10 0			
						75 9 2		
				for Reprints:				
				Vol. 17 (1951)	£9 10 7			
				„ 18 (1952)	4 14 9			
				„ 19 (1953)	4 10 0			
				„ 20 (1954)	110 0 6			
						128 15 10		
				for Back Numbers:				
				Vol. 19 (1953)	5 0			
				„ 20 (1954)	£2 3 0			
						2 8 0		
								285 2 7
				Stock of Reprints: Vol. 20, No. 4				48 1 0
		£704 12 5						£704 12 5

We report that the above Income & Expenditure Statement and Balance Sheet show a true and correct statement of the financial activities of the Institute for the year ended 31st December, 1954, according to the information and explanations given to us and as shown by the books and records of the Institute.

(Sgd.) CLEVELAND, SON & HISLOP,
Chartered Accountants (Aust.).

LETTERS TO THE EDITOR

Sir,

A recent addition to *Agricultural Engineering*, which in my opinion is worth emulating in the Journal, is a "Catalogue of Graduate Theses in Agricultural Engineering" showing title of the paper, author, date of acceptance and place where available for reference.

Many theses are only records in the archives of Universities and far too frequently the findings of the author are not even heard of by others interested in the same problems, so if some sort of summary were available, a lot of unnecessary duplication could be avoided.

To make a firm proposal let me suggest, "that all papers accepted for M.Agr.Sc., Ph.D. and M.Sc. degrees, where of interest to agriculture, if the University concerned is agreeable, be reported by a synopsis of say one to four hundred words in the Journal as soon as possible after their lodgement." Further, "papers already submitted could, as opportunity is available, be summarised and presented in the Journal."

I feel sure the authors would be only too pleased to make available such a precis which would give readers a better report than if anyone else read the paper and made an independent summary, placing perhaps a wrong emphasis on the findings and the resulting fund of information would be of world-wide interest and importance.

A. W. BYRNES.
State Rivers and Water Supply Commission,
Heyfield, Victoria.
August 2, 1955.

Editor's Note: This is an excellent suggestion, it will be discussed fully at the next Publications Committee meeting and every effort will be made to implement the proposal.

BOOK REVIEWS *(See also pages 162 and 188)*

PRACTICAL HORTICULTURE

By J. S. SHOEMAKER and B. J. E. TESKEY

(*New York, John Wiley; London, Chapman and Hall;* 1955, $4.20.)

This work, which is one of the Wiley Farm Series, "designed for agricultural students, farmers and persons engaged in farm service employment," could best be described as a digest of horticultural methods as practised under Northern American conditions.

The preface states "the book has been written primarily for students of vocational agriculture . . . the effort has been directed towards making the advice and instructions, simple, practical and easy to follow." The question as to whether the authors have fully achieved their objects can only be fully answered by those familiar with horticultural conditions and practices in North America but there seems little doubt that for students undertaking horticultural courses there, the work could have considerable value as a text book if their studies are supplemented by oral and practical instruction and amplified by further study of other reference books, some of which are referred to in the text.

It is difficult to see any useful application for students undertaking horticultural courses in Australia, other than as an interesting review of what is practised under the cooler conditions of Canada and North America generally. Many of the methods and species and varieties dealt with are just not applicable here on account of climatic and for other various reasons. In regard to the species of trees and shrubs dealt with, this is all the more so as so many of these are only mentioned by their apparently local vernacular names, without any reference to their botanical nomenclature.

The authors have certainly succeeded in covering all branches of ornamental gardening, vegetable growing (which represents about half the total space) and fruit growing, but in such a tabloid form that considerable amplification would be necessary even to the Canadian or American student. As instances, the huge subject of landscape gardening is covered in 13 pages; ornamental trees, shrubs and vines, 14 pages; annuals, biennials and perennials, also 14 pages, apple and pear culture is "covered" in 16 pages and vegetable growing gets the best coverage in 10 chapters, totalling 145 pages. Perhaps the most interesting part of the book to an Australian reader is the first chapter which discusses "Horticulture as an Art, Science and Business" which in its 9 pages, succinctly describes the many and various phases of horticulture as possible careers for trained horticulturalists.

G. HYAM.

BOOK REVIEWS

SOIL AND WATER CONSERVATION ENGINEERING

By R. K. FREVERT, G. O. SCHWAB, T. W. EDMINSTER and K. K. BARNES

(*N.Y., John Wiley*, 1955, $8.00.)

Soil and water conservation engineering is a science which, in the U.S.A., has developed to the stage where enough data is available to enable the authors of this publication to present a valuable and comprehensive text. Australia, the driest of all the continents, stands to benefit greatly from endeavours in this field. Although the subject matter of this book is drawn largely from American experience, there is little that is not directly applicable to the field of conservation in this country.

The book begins with a concise review of hydrology and soil physics, which strengthens the treatment of the various aspects of soil and water conservation engineering that follow. Aspects dealt with include control of wind erosion, gully control, earth dams, flood control, surface and sub-surface drainage, pumping equipment, sprinkler irrigation, land clearing, concluding with a chapter on the legal aspects of soil and water conservation. All these subjects, which are soundly and concisely treated, have a growing importance in Australia. In the chapter dealing with gully control, the statement "the opportunity to provide protective cover by natural revegetation frequently is overlooked" is of interest, the same tendency having been noted in this country.

The necessity for sound engineering design is stressed as a pre-requisite for successful conservation measures, which must include the careful selection and integration of all known conservation practices. Although containing considerable basic data, this book will not have enough detailed information, in some instances, for the practising engineer.

Four authors have contributed to this volume, which is of especial value because of its synthesis of information from a wide variety of sources, and for its emphasis on the analytical approach. Sufficient field data has been supplied to point out many practical applications. This, as well as class problems and selective bibliographies at the end of each chapter, make this an excellent choice for teaching and general reference purposes.

The book was sponsored by the Ferguson Foundation, and represents one of a series of books on agricultural engineering sponsored by that organisation.

R. J. McCUBBING.

BOOK LIST

Notice has been received that the following books on agricultural topics have been published recently:—

BAILEY, Irving W.—Contributions to plant anatomy. (Chronica Botanica, v. 15, Nos. 1-6.) *Waltham (Mass.), Chronica Botanica Co.*, 1954. No price given.

BURLEW, John S.—Algal culture: from laboratory to pilot plant. Carnegie Institution of Washington publication 600. Washington, 1953. $1.25.

EGISTI, O. J. *and* DUSTIN, Pierre Jr.—Colchicine—in agriculture, medicine, biology and chemistry. *Ames (Iowa), Iowa State College Press*, 1955. $5.00.

FREVERT, Richard K. *and others*—Soil and water conservation engineering. *N.Y., John Wiley, London, Chapman & Hall*, 1955. $8.00.

HAYES, H. K., IMMER, F. R. *and* SMITH D. C.—Methods of plant breeding. 2nd ed. *N.Y., McGraw-Hill*, 1955. $8.50.

HENDERSON, S. M. *and* PERRY, R. L.—Agricultural process engineering. *N.Y., John Wiley, London, Chapman & Hall*, 1955. $8.50.

HEUSER, Gustave F.—Feeding poultry. 2nd ed. *New York, John Wiley*, 1950. $7.50.

IMPACT OF SCIENCE ON SOCIETY—quarterly published by U.N.E.S.C.O., 19 Avenue Kleber, Paris 16, France. A12/6 p.a. v. 5, No. 2. June, 1954. Contents: Scientific progress and the evolution of International law. The human element in the application of science. Photosynthesis and algal culture.

G. M. H. LAWRENCE *and others*—Plant genera, their nature and definition. A symposium. (Chronica Botanica, v. 14, No. 3.) *Waltham (Mass.), Chronica Botanica Co.*, 1953. $2.00.

MacEWAN, Grant—Feeding of farm animals. *Toronto, Thomas Nelson & Sons Ltd.*, 1946. $4.00.

MERRILL, Elmer Drew—The botany of Cook's voyages. (Chronica Botanica, v. 14, Nos. 5-6.) *Waltham (Mass.), Chronica Botanica*, 1954. No price given.

SMITH, Harris Pearson—Farm machinery and equipment. 4th ed. *N.Y., McGraw-Hill*, 1955. $7.50.

WILSON, Harold K.—Grain crops. 2nd ed. *N.Y., McGraw-Hill*, 1955. $6.50.

APPOINTMENTS AVAILABLE

PUBLIC SERVICE OF SOUTH AUSTRALIA

Applications for the position set out hereunder will be received by the Public Service Commissioner, 31 Flinders Street, Adelaide, until and including Monday, 3rd October, 1955.

Applicants should state full names, address, date of birth, marital status, academic qualifications, practical experience, and give particulars of war service (if any). Copies only of testimonials should be submitted with the application.

The appointee may be required to contribute to the Government Superannuation Fund.

SALARY QUOTED IS ACTUAL

Agriculture Department.

FIELD OFFICERS or PROJECT OFFICERS SOIL CONSERVATION BRANCH.

Salary Ranges : £870/£980 or £945/£1,060 according to experience.

Applications are invited from Agricultural Diploma holders for positions in the Soil Conservation Branch. While the work of the Branch is devoted to Soil Conservation practices, it is closely associated with the general agricultural work of the Department and advancement is therefore not confined to channels through the Soil Conservation Branch.

Appointees would be required to work at country centres as Field Officers.

PUBLIC SERVICE OF TASMANIA

Applications, closing on the 30th September, are invited for the position of SHEEP AND WOOL OFFICER, Department of Agriculture.

Salary Range : £1,232-£1,385 per annum, inclusive of cost of living allowance.

Duties : Appointee would be required to provide a specialised advisory service in one or other of the fields of fat lamb production or wool growing, to supervise and initiate research in his particular field, and to conduct field days and demonstrations.

Qualifications : Applicants should possess a degree in Agricultural or Veterinary Science, or a diploma from a recognised Agricultural College. A sound general experience in sheep husbandry and wool is necessary and specialist experience either in fat lamb production and British breeds or in wool and dual purpose breeds is desirable. A wool classing diploma and experience in research work or stud management would be advantageous.

Cost of fare of appointee, and family, together with cost of carriage of furniture up to three tons in weight will be refunded on certain conditions being fulfilled.

Applications, stating personal details, etc., are to be forwarded to the undersigned from whom further particulars may be obtained.

A. LINTON,
Secretary,
Public Service Commissioner's Office.

COMMONWEALTH SCIENTIFIC & INDUSTRIAL RESEARCH ORGANIZATION

TECHNICAL OFFICER—DIVISION OF ANIMAL HEALTH AND PRODUCTION

Location : National Field Station, "Gilruth Plains," Cunnamulla, Queensland.

Duties : To assist the Officer-in-Charge in investigations in animal husbandry associated with extensive sheep breeding studies, including the making and recording of observations connected therewith. Current investigations deal with selection methods in Merino sheep and the adaptation of different strains of the Merino to the environment of South West Queensland.

Qualifications : University degree in Veterinary Science or Agricultural Science. An ability to keep satisfactorily extensive sheep breeding records must be shown by the successful applicant. An interest in sheep breeding and animal genetics is essential.

Salary: Dependent on qualifications and experience, commencing salary will be determined within the range of Technical Officer, £890-£1,310 p.a.

Note :

(a) The above salaries apply to a male appointee.

(b) The position is one for a single male.

(c) A District Allowance of £40 p.a. is payable. Board and Quarters are provided for a salary deduction of £2/10/- per week.

Applications in applicant's handwriting and referring to appointment number 210/24, should reach the Officer-in-Charge, National Field Station, C.S.I.R.O., Gilruth Plains, Cunnamulla, Queensland, not later than 30th October, 1955.

TECHNICAL OFFICER—WILDLIFE SURVEY SECTION

Location : Griffith, N.S.W.

Duties : To assist research staff in investigations of the biology and movements of, and damage to irrigated rice caused by, ducks in N.S.W. and magpie geese in Northern Australia, and other ornithological problems.

Qualifications : Degree in science or agricultural science or equivalent, with experience or training in zoology.

Salary : Dependent on qualifications and experience, commencing salary will be determined within the range of Technical Officer, £890-£1,310 p.a.

Applications referring to appointment number 563/3 should reach the Officer-in-Charge, Wildlife Survey Section, C.S.I.R.O., P.O. Box 109, City, Canberra, A.C.T., not later than 14th October, 1955.

See also Appointments Available, Page 144.

PUBLIC SERVICES OF COMMONWEALTH TERRITORIES

PAPUA AND NEW GUINEA

DEPARTMENT OF AGRICULTURE, STOCK AND FISHERIES

AGRICULTURAL OFFICER GRADE I.

£1,040-£1,544 p.a.
(3 positions.)

Qualifications : (a) Degree in Agriculture (students graduating this year may apply) or (b) Diploma of approved College plus suitable experience, preferably in tropics.

Duties : Extension duties, supervise special projects, technical duties for specialist divisions, maintain agricultural stations.

ASSISTANT AGRICULTURAL OFFICER.

£657-£1,208.
(8 positions.)
(See also under "Salary.")

Qualifications : Diploma of approved College. NOTE.—Students graduating this year may apply.

Duties : Extension duties, supervise special projects, technical duties for specialist divisions.

Eligibility : British subjects 18 years but under 45.

SOIL SURVEY OFFICER GRADE I.

£1,040-£1,544 p.a.
(2 positions.)

Qualifications : Degree in Agriculture or equivalent, major in Soil Science desirable. NOTE.—Students graduating this year may apply.

Duties : Soil surveys, prepare maps.

AGRONOMIST GRADE I.

£1,040-£1,544 p.a.
(5 positions.)

Qualifications : Degree in Agriculture or equivalent, major in Agronomv preferred. NOTE.—Students graduating this year may apply.

Duties : Experimental crop work.

ENTOMOLOGIST GRADE I.

£1,040-£1,544 p.a.
(2 positions.)

ENTOMOLOGIST GRADE II.

£1,544-£1,712 p.a.

Qualifications : Degree in Agriculture or equivalent, preferably with major in entomology. Students graduating this year considered for Grade I. For Grade II, post-graduate work in research and economic entomology.

Duties : Pest control experiments, bionomic studies of pests.

ANIMAL HUSBANDRY OFFICER GRADE I.

£1,376-£1,544 p.a.

Qualifications : Degree in Veterinary Science or related Science.

Duties : Field trials and experimental work.

ASSISTANT ANIMAL HUSBANDRY OFFICER.

£1,040-£1,208 p.a.

Qualifications : Diploma of approved College (or equivalent knowledge) of animal husbandry, nutrition, pasture improvement, stock and station management.

Duties : Implement field trials and experimental work. Maintain records on animal breeding, nutrition and production.

LABORATORY OFFICER.

£1,040-£1,460 p.a.

Qualifications : Degree from University of Technology or equivalent Technical College Diploma.

Duties : Preparation of cultures, media and specimens; conduct laboratory examinations and implement experimental procedures as directed.

Location : Port Moresby.

PARASITOLOGIST GRADE II.

£1,628-£1,796 p.a.

Qualifications : Degree in Veterinary Science or related science, knowledge laboratory technique.

Duties : Experimental and diagnostic work as directed.

Location : Port Moresby.

PUBLICATIONS OFFICER.

£1,754-£1,880 p.a.

Qualifications : Leaving Certificate or equivalent, proven literary ability; degree or diploma in Agricultural Science preferred but not essential. Experienced editor agricultural and pastoral publications.

Duties : Assemble and edit data for bulletins, circulars, lectures, etc. Supervise and stock departmental library.

Location : Port Moresby.

Department of Agriculture, Stock and Fisheries, (Continued).

VETERINARY OFFICER GRADE I.
£1,376-£1,544.

VETERINARY OFFICER GRADE II.
£1,628-£1,796.

VETERINARY OFFICER GRADE III.
£1,754-£1,880.

(Several positions in each grade.)

Qualifications : Degree in Veterinary Science. Sound knowledge disease control, animal husbandry. Post-graduate experience essential for Grade II and III vacancies. Students graduating this year may apply for Grade I positions.

Duties : Disease control, animal husbandry, quarantine work, stock management. Administrative duties relevant to position.

GENERAL INFORMATION

Salary : Ranges quoted include cost of living and Territorial Allowance but married officers receive an additional £100 p.a. Advancement is by annual increments within ranges.

Appointees as Assistant Agricultural Officers are paid as follows:—

	£
At 18 years	657
At 19 years	769
At 20 years	880
At 21 years	945
At 22 years	945
At 23 years	956

Irrespective of age, appointees as Assistant Agricultural Officer, with 3 years post-diploma experience in Territory Service or 4 years elsewhere, receive commencing salary of £1,040 p.a.

Eligibility : Adult male British subjects under 45 years (except where stated).

Appointment : Permanent, subject to satisfactory probationary period.

Location : Appointees are required to serve anywhere in the Territory. Where location is stated it refers to headquarters or initial posting only.

Accommodation : Single accommodation available. Married accommodation unlikely to be available under eighteen months.

Separation Allowance : Payable at discretion of Territory Administration and designed to compensate for added expense of married appointees obliged to maintain family outside Territory.

Leave : Three months after each twenty-one months in Territory. Additional three months' leave after each six years' service and six months' furlough after twenty years' service.

Taxation : Income derived by residents of Territory from sources within Territory is not at present taxable under Commonwealth legislation.

Further Information : Information Handbooks on the Public Service of the Territory are available from any official country Post Office, District Employment Office, Commonwealth Public Service Inspector or from Department of Territories, Canberra or Sydney. Other enquiries to Department of Territories, Canberra. ('Phone F 0411, Extension 28A.)

Applications : Submit on prescribed form, available from offices mentioned in General Information Section—

To Secretary, Department of Territories, Canberra, A.C.T., by 8th October.

Notice to Members

Members will note the interest shown by Advertisers in their Journal.

Practical appreciation of their valuable support can best be demonstrated by according them patronage whenever possible.

DU PONT

AGRICULTURAL CHEMICALS

Du Pont agricultural chemicals, produced by the Grasselli Department of Messrs. E. I. Du Pont de Nemours & Co. of Wilmington, Delaware, U.S.A., are now available in Australia for use in agricultural, horticultural and pastoral industries. The following products constitute the current range:

MANZATE. Manzate is a fungicide based on the chemical Manganese ethylene bisdithiocarbamate. This material has been specially developed for control of fungus diseases in potatoes and tomatoes and in fruit and vegetable crops.

PARZATE. Parzate is a fungicide based on Zinc ethylene bisdithiocarbamate for use against fungus diseases on a wide range of crops, including potatoes.

FERMATE. This is a fungicide based on Ferric dimethyldithiocarbamate. This material is particularly useful for control of tobacco fungus diseases.

METHOXYCHLOR INSECTICIDES. A number of formulations, based on Methoxychlor, are now available. These include Marlate 50, a 50% wettable powder for use on fruit and vegetables, and Marlate 2-MR, an emulsifiable oil, and Dairy Cattle Spray. These last mentioned sprays are for use wherever stock are handled.

C.M.U. WEED KILLER. This material is based on 3-(p-chlorophenyl)-1, 1-dimethylurea. It is a non-poisonous total weed killer, which is effective for long periods. At very low dilution it is ideal for pre-emergence control of weeds in crops as divergent as sugar cane and asparagus.

AMMATE WEED AND BRUSH KILLER. This material is based on Ammonium sulfamate and it is ideal for control of eucalypt suckers and other tree species. It will control Mallee shoots, Crofton weed and most perennial weeds and brush.

Further information is readily available upon request.

Sole Distributors for Australia, New Zealand and the Mandated Territories:

Mobile Industrial Equipment Limited

410-416 WHITEHORSE ROAD, MITCHAM, VICTORIA . . . . . TELEPHONE: WU 1081 (9 lines)
BRANCHES: SYDNEY, BRISBANE, ADELAIDE, PERTH. TELEGRAMS: "MOBILCO". REGISTERED ALL CAPITAL CITIES

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